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COMMUNICATION OF INFORMATION AND KNOWLEDGE

ALTHOUGH the meeting of the British Association at Dundee illustrated fairly enough, as it was planned to do, the great contribution which science can make to the task of building a better and a more stable world, there was easily discernible some even deeper thinking about the central issues that confront governments and peoples to-day. Some of the addresses, notably that of Prof. Dennis Robertson to Section F (Economics and Statistics), frankly challenged complacent and woolly thinking about planning and its limitations, while the presidential address itself touched on some deeper issues. When Sir Henry Dale suggested that there might be danger to science from a tendency to transfer too easily and completely, to the activities of peace, the attitude to research and the traditions of its conduct which have been acquired during six years of war experience, he was probably not thinking solely of the need of extending the fundamental investigations suspended or restricted by war, or of the trammels of scientific communication imposed by the obligations of secrecy.

Behind that plea for less secrecy and greater freedom of communication lies the much larger question of communication of knowledge in general. The threat to freedom of communication in science is only real in so far as conditions exist which threaten freedom of communication in general, and some of the sectional discussions at Dundee put this question of communication in its true light. It is a first condition of social cohesion and an essential factor in effective co-operation. It is more than the connective tissue of society; it is the nervous tissue as well.

That was well illustrated in the discussions on operational research in war and peace, on incentives in industry, and on public opinion surveys; and neglect of this factor has contributed seriously to the difficulties of Great Britain at the moment. In no department of administration has the Government more signally failed than in this matter of public relations. In one measure after another, it has not sought to secure, before introducing new measures, the full public understanding and support which are essential for the success of legislative or administrative action alike; and what the Government has not done itself, it has indirectly if not deliberately hindered the Press from doing. Few things, indeed, show up more clearly the consequences of the restrictions on newsprint than the contrast between the treatment by the Press of the Dundee meeting of the British Association and that of the last full meeting of the Association before the War. Limitations of space have prevented any reporting at all of numerous important discussions, and in consequence the educative value of the meeting has been more severely restricted to those present than at any time in the last century.

It is a further sign of the Government's ineptitude in the matter of communication, in spite of lip-service to the support and spread of scientific knowledge, that this moment should be chosen to re-

impose the licensing system for the import of books; a measure which proved such a serious handicap to scientific and technical men during the War. Leaving on one side for the moment the consideration of the cultural aspect of this hindrance to the interchange of ideas and thought, at a time when the United Nations Educational, Scientific and Cultural Organisation is endeavouring to remove such obstacles, the restoration of a licensing system will put a new obstacle in the way of research workers obtaining the tools they need. Government policy, as well as the consequences of our own war effort, have concentrated the production of new scientific and technical books in overseas hands, largely in the United States; consequently, an immediate and indirect effect of the new Board of Trade order will be to hinder the increased industrial efficiency and development which the Government wishes to promote.

Such checks on discussion and communication are, in fact, much more serious than the limitations imposed by secrecy obligations, for example, in regard to atomic energy. No one can suggest that, in this field, Great Britain or the United States can disregard the implications of the new law in the U.S.S.R. regarding official activities; but in the atomic energy field it is the risk of administrative stupidity or incompetence in the administration of the Atomic Energy Act that lies at the root of any real fears as to its effect on the interchange of scientific knowledge, as distinct from the technical information relating to military applications. No well-informed person to-day will support the suggestion that the great bulk of industrial research work that is of scientific interest is not now published. British industry is now in no way behind American industry in this respect. It might even be held that it is in advance, in that more discrimination is exercised and negative results of no scientific significance do not clutter the pages of British scientific periodicals. The limiting factor is not the restraint on publication exercised by the industrial firm, but the reluctance or inertia of the scientific worker himself in the matter of preparing his results for publication before proceeding with further investigations.

Although, therefore, the secrecy threat to freedom of communication in science is apt to be overstressed, it cannot be denied that the existence of the new Russian law on the disclosure of State 'secrets', with its wide implications and restraints over the whole of industry, agriculture, science and technology, is liable to provoke Government intervention in other countries also, and so hinder the full development of science. That is true in the United States no less than in Great Britain; science thrives best under the conditions of full freedom of thought and discussion which best enable us to draw collectively upon all the resources of wisdom, statesmanship and goodwill which we possess.

Some recent publications of the American Academy of Political and Social Science are of interest and importance in this connexion for the positive suggestions they contain. For example, a paper by Dr. Sumner H. Slichter, "Some Economic Consequences of Science" (*Ann. Amer. Acad. Pol. and Soc. Sci.*, **249**, 99; 1946) directs attention to the importance of extending our knowledge of techniques available for diminishing controversy and increasing the use of co-operative attacks upon problems, and of the conditions which determine the capacity of individuals to participate intelligently in the affairs of the community and to supervise effectively their representatives responsible for making and executing policies. Progress in these two fields would enormously increase the capacity of the community to serve its problems and to adjust itself to changes. The formulation of specific programmes in these fields is the task of the social scientist, and Dr. Louis Wirth also contributes a valuable paper on the "Responsibility of Social Science", in which he discusses the reasons for the failure of social science to gain wide public acceptance, and reports on the conditions required to enable research in social science to make its full contribution to the solution of problems arising out of the impact of science upon society. Significantly enough, Dr. Wirth himself suggests that such research will be inadequate unless it includes the search for knowledge on power relations among men, and the means for generating the will and the capacity for action directed toward the achievement of a good society. The social scientist is, in fact, coming to recognize the importance of investigating just those fields to which the economist is directing attention in considering the limitations of social and economic planning; while psychologists themselves, as Prof. Donald C. Marquis shows in a paper on "Psychology of Social Change", are approaching the many problems opening up in the field of communications as it bears on social therapy and the establishment of international as well as national or industrial understanding and order. The accurate measurement at frequent intervals of the status of public opinion on international questions; the study of the basis of such attitudes by examining their relation to the quantity and kind of information held by the individuals, and their relation to other attitudes, convictions and individual traits; and the study of the means of reaching and affecting people individually and in groups—all these are fields in which Prof. Marquis believes research could yield most fruitful results.

The improvement of means of communication of information is a first responsibility, and important as it may be to improve and extend what is generally known as public relations work in respect of the flow of information, both to the public, and also to the Government as regards the trend of opinion, and for research in this field, the first task is the elementary one of securing that there is no impairment of the established channels while the new techniques—classroom communication and group discussion, the use of radio, the motion picture and advertising, or what E. L. Bernays terms the engineering of consent—are being explored and developed.

These possibilities are well brought out in the series of papers issued by the American Academy of Political and Social Science (*Annals*, **248–251**), which touch, too, on those problems in the relationship of management and labour involved in the

use of such bodies as the production committee or works council as means of communication. But no one who studies this symposium of papers, thinking of the avenues of sociological research which they indicate, will be led by that vista to forget the elementary duties which lie to hand for every responsible citizen. We must, indeed, improve our channels and means of communication in both directions, alike between Government and governed, manager and operative; but above all, as Prof. Williamson and the Hon. Karl E. Mundt both indicate, we must so far as is possible replace Government control, direct or indirect, over sources of information and means of communication, by the conscious and spontaneous self-control exercised by those who recognize that a great social system can only be built on rational action and on some sacrifice of personal interest to the welfare of the community.

There are old as well as new techniques which can be used to enable the community to understand the need for this sense of social responsibility. There is no greater danger to a free people than that of dictation or of neglect by the Government to dig deep the channels of assent to legislative or administrative action. The papers in these volumes from the American Academy of Political and Social Science, as well as the discussions at the Dundee meeting of the British Association, demonstrate how grave is the situation and how important it is that further research into this question of communication, its techniques and organisation, should be pressed forward from the point of view of production and national recovery. They show also that all men of goodwill should unite to resist the encroachments on the old freedom of thought and utterance which war-time practices and administrative ineptitude are still making, both in the field of science and in the world at large.

THE PREDICTION OF NATURAL FREQUENCIES OF VIBRATION

The Escalator Method in Engineering Vibration Problems

By Joseph Morris. Pp. xv + 270. (London: Chapman and Hall, Ltd., 1947.) 21*s*. net.

THE problem of calculating the natural frequencies of a dynamical system is of considerable technical importance in many branches of engineering and not least in that branch of engineering called instrument-making. It is important for the designer to be able to predict natural frequencies for two main reasons. First, in order to avoid the occurrence of resonance, that is, agreement of a natural frequency with that of some periodic forcing agency; this is of particular importance in rotating and reciprocating machinery, where persistent resonance in service is dangerous. Secondly, in instruments where response and stimulus should be linearly related over a band of frequencies, approach to resonance cannot be allowed, as this destroys the required characteristic. All this is true of electrical and of electro-mechanical systems as well as of purely mechanical ones.

The main purpose of the book under review is to put forward a method for calculating the natural frequencies and modes of systems having a finite number of degrees of freedom, or which can be represented as such. The special feature of the method, which is indicated by the word 'escalator', is that the solution is worked out in a succession of steps in each of which the number of degrees of freedom is one greater than for the previous step, until the full number in the system is attained. Determinants are not used, and the equations determining the frequencies and modal ratios at each stage are easily constructed from the results obtained at the previous stage.

The reviewer believes the method to be new, and the examples included in the book amply demonstrate that it is workable and useful in the hands of an expert. Whether the inventor's great enthusiasm for the method is fully justified only experience can settle. Undoubtedly the method is particularly well suited to those problems where most of the dynamical system is constant but where parts of it are subject to variation, for it may be possible so to arrange the calculations that the variable elements only appear in the last stages of the 'escalator'. When this is so, considerable saving in labour may result. It is just on the question of economy of labour for results of given accuracy that the method must be judged, as it has no advantage of elegance and, of course, it yields theoretically the same results as orthodox processes. It should be added that the special advantage just mentioned is not peculiar to the Morris escalator; it is shared to some extent, for example, by the method of partition or of sub-matrices.

The contents of the book are considerably wider than the title would indicate, for the first seven chapters are devoted to discussions of problems in the statics of beams and structures. A welcome feature is the inclusion here of a chapter on the Hardy Cross method and some of its extensions, but the author does not remark the fact that all such methods are essentially the same as the Gauss–Seidel method for the iterative solution of simultaneous linear equations. Applications of the escalator process, for the most part to problems arising in aeronautics, occupy the last eleven chapters.

Unquestionably the author has written a stimulating and useful book which embodies the results of many years of enthusiastic work, and he is to be congratulated on bringing this to fruition. The reviewer must express his regret that the author has never adopted the notation of matrices in his work on vibrations and structures, since the gain in clarity and conciseness is enormous. W. J. DUNCAN

THE FINAL INTEGRATION

The Integrative Action of the Nervous System

By Sir Charles Sherrington. With a new Foreword by the Author and a Bibliography of his Writings. Pp. xxvi+433. (Cambridge: At the University Press, 1947.) 25*s*. net.

IN July the seventeenth meeting of the International Physiological Congress was held in Oxford. It was the first since the meeting at Zurich in 1938, and like other post-war congresses it was a most enjoyable reunion. The organising committee had many problems to face in planning for a meeting with an attendance of 1,300; but at least it had no difficulty in choosing an appropriate gift to the

members. What was needed was some classical English work on physiology; for a congress at Oxford, therefore, what better choice could have been made than a new edition of Sherrington's Silliman Lectures, "The Integrative Action of the Nervous System"? This famous book was published in 1906: it laid the foundations of the neurophysiology of the brain and spinal cord as we know it to-day, and though it has been out of print for some years it is still an essential introduction to the study of the central nervous system.

The Yale University Press, the original publishers, kindly allowed the Physiological Society to bring out a fresh edition. The preparation was entrusted to Prof. Samson Wright, and all physiologists and neurologists will be grateful for what he has done. The text is reproduced without alteration; but the blocks have been redrawn, a bibliography and a photograph of the author have been added, and, best of all, a foreword by him specially written for this edition. In it Sherrington has given us his mature judgment on the wider issues raised by his work. By isolating the spinal cord from the dominance of the brain he was able to analyse the mechanism of simple reflex behaviour. In the brainless animal we study the automatic responses of a 'Cartesian puppet', and the simple reflexes give the clue to its nervous machinery. They are, for the most part, convenient experimental abstractions; they have been most valuable in understanding the integrated behaviour of the whole organism, but clearly they are not enough. In man at least we shall never understand behaviour unless we bring in mental as well as physical events.

In "Man on His Nature", Sherrington has dealt with this cardinal problem of neurology, and in these twelve introductory pages he returns to the theme, stressing the difficulty of welding together the two incommensurables, the physical and the psychical series of events. The liaison between them is a problem still unsolved, remaining where Aristotle left it more than two thousand years ago; but Sherrington's discussion of "the last and final integration" gives it physiological as well as philosophic interest. Though the duality remains we can face it more boldly when we think of the amazingly complex adjustments which the mindless animal can carry out. Indeed, when we consider the behaviour of a series of animals with more and more elaborate nervous systems, it would be quite impossible to say where psychical activity begins. It is present in man at all events, and the final chapter in Sherrington's book points the way to its study in terms of the physical apparatus of binocular vision.

The experiments on reflex activity described in the earlier chapters were made at a time when the graphic recording of muscular contraction was the most accurate method of following the time course of spinal excitation. Nowadays, electrical methods give a precision reckoned in tenths of milliseconds instead of tenths of seconds. The finer details of the reflex arcs have been explored and the literature of synaptic conduction would run into volumes. Yet Sherrington's work remains the framework for any detailed picture of nervous integration; what he describes as his "rather elderly volume" has lost none of its vitality. It is a work which British physiologists were proud to give to their colleagues in celebration of the Oxford congress.

E. D. Adrian

THORPE'S DICTIONARY OF APPLIED CHEMISTRY

Thorpe's Dictionary of Applied Chemistry
Fourth edition, revised and enlarged. Vol. 7: Iodazide—Metellagic Acid. With an Index by Dr. J. N. Goldsmith. Pp. xii+629. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1946.) 80s. net.

THE third edition of "Thorpe" originally ran into seven volumes. The fourth, in the same span, takes us only halfway through the alphabet, and if the standard were maintained (and it can be stated forthwith that it is) on simple proportion we might expect it to be twice as useful. In fact, the ratio is even higher since, with the exception of a few short items, mainly on minerals, the whole of the subject-matter has been rewritten, only the more important parts of the older material being retained and incorporated with the new matter. Merely to browse through this book is a most salutary proceeding for, apart from inducing a fuller appreciation of all the work that has been involved in the production, it brings home with a startling jolt how much there is that one does not know. It follows that, when in search of a piece of information, it is wise to "look it up in Thorpe" first. Of course, the answer is not always there; no one book or set of books could contain all the answers; but the state of the volumes of "Thorpe" after several years in a library or general laboratory is a dumb token of appreciation.

One of the fascinating features of "Thorpe" is the width of the net which it casts. No better example of this could be given than the article on 'Lichen Substances'. This is an interesting group if only because it contains the few naturally occurring organic compounds containing chlorine so far known; but also it is one which does not reach the limelight to the same extent as some other plant products such as the alkaloids or the essential oils with their more practical applications. That the subject is not overlooked by chemists is clearly indicated by the extension which has been called for in the revised article. The lactones form another group well represented in Nature, but these have spread through commercial demands for coumarin and undecalactone, to mention just two, into the realm of the chemical works. Butyrolactone comes within the range of Reppe's acetylene programme; but it is rather early for the information on this remarkable work to have penetrated beyond the special reports thereon.

As a good example of the appreciation (using the word in both senses) of values, the subject of lignin, formerly dismissed in a few lines, is now allocated more appropriate space in view of recent developments, particularly in the United States. The new article on meat extract presents a very fair picture of a subject on which there has been much divided opinion.

In accordance with the expressed policy of the new editorial board of extending the increasingly important physico-chemical subjects, topics such as magneto-chemistry, mass spectra, membrane equilibria, luminescence, mesomerism, liquid crystals, structure of liquids are dealt with at some length. No one, least of all the authors, would claim that these articles are a complete guide to the subjects, but further guidance is given by the inclusion of extensive bibliographies. Among the smaller contributions of this type may be mentioned isoelectric point, lyo-

tropic series, Kerr constant, ionization potentials, isochore and Joule's equivalent.

The general treatment of such of the elements as fall within the literal scope of this volume follows the familiar lines of describing, as appropriate, occurrence, extraction, refining, physical and chemical properties, uses, alloys and compounds, both inorganic and organic; naturally one does not expect to find here all the minutiæ given in "Mellor".

Some disappointment was felt at the lack of detail on the nature of additives for lubricating oils; but, in fairness, it must be admitted that a plea of extenuating circumstances can justifiably be made. On one hand, the number of compounds which have been proposed for the purpose is enormous, while on the other, commercial reticence about those which are actually used is natural enough; moreover, it is doubtful whether the precise nature of some of these products is known.

It would be an invidious task to quote names of contributors; suffice it to say that they are such as to command the respect due to authority in their various fields. On the material side, the now familiar jacket of blue is maintained undimmed, but the stringency of the paper position is reflected in an irregular alternation of colour coupled with quality. The paper is adequate, but it is to be hoped that supplies of at least a uniform tint will be available for subsequent volumes. However, better a "Thorpe" in cream and white rather than no "Thorpe" at all.

B. A. Ellis

SOCIAL IMPROVEMENT BY EDUCATION

Some Tasks for Education

By Sir Richard Livingstone. Pp. vii+98. (London, New York and Toronto: Oxford University Press, 1946.) 5s. net.

THE four lectures in this volume were delivered in September 1945 at the University of Toronto—the first three on the Burwash Foundation and the fourth as the Sir Robert Falconer Memorial Lecture. Although they are not consecutive, all deal with aspects of a single problem—how to improve ourselves and our society by education—and are a valuable corrective to the current obsession of educationists for dealing with means rather than ends. Those who are familiar with Sir Richard's earlier writings will not be surprised to find that, although he examines proposed revisions of curricula to meet the needs of the modern world, he is chiefly concerned to emphasize, as the prior task of education, the need "to inspire and to give a sense of values and the power to distinguish what is first-rate . . . from what is not". "It is", he declares, "right to teach the pupil to criticize, but it is even more important to train him concurrently to admire." To him "nothing—not all the knowledge in the world—educates like the vision of greatness, and nothing can take its place".

The most challenging passages in these lectures are concerned with the training of character. While the creation of the first-rate in art, literature, thought and science must still be—as it has been in the past—the prerogative of the few, Sir Richard has no doubt about the ability of every human being to create the first-rate in the field of character. His indictment of modern education is its failure to afford this opportunity to every individual. Is it, as he suggests, really true "that in most modern educational schemes the training of character, if not neglected, has been given a subordinate place; that we have very little, if anything, like the concentration on it in Plato's thought and in Arnold's practice?" It may well be that the only way to learn social habits is "by living a life in which such habits automatically develop", but does it necessarily follow that the training of character is difficult, if not impossible, outside the British boarding school?

Educationists who have to struggle with conditions far inferior to those found in the public schools may justifiably be irritated by Sir Richard's preoccupation with Plato, boarding schools and Periclean democracy. Nevertheless, if he is right that the British boarding school has been the finest factory of citizenship in existence, few will be able to gainsay his conclusion that "we should give to the many some equivalent of the training we have given to the few".

MATHEMATICAL STATISTICS

Introduction to Mathematical Statistics

By Assoc. Prof. Paul G. Hoel. Pp. x + 258. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 3.50 dollars.

ONE consequence of the 'export drive' in Britain is likely to be a much increased demand for the mathematical statistician in industry; unfortunately the supply of suitable people is still far too small, and this must largely be attributed to the shortage of teachers and the absence of suitable text-books. Hoel's "Introduction to Mathematical Statistics" seems to me to be an excellent work, and if only it can become generally available it may have a most favourable effect on the situation just described. In spite of the restrictive effect of the present licensing system, means should be found of introducing the book widely in Britain. Placed in the hands of any intelligent mathematical undergraduate, it will give him in a few weeks not only familiarity with the broad outlines of the subject but also a real understanding of the types of problem with which the research worker in this field is contending.

The first six chapters cover the usual introductory material, in a manner at once accurate and attractive. There follow brief accounts of a variety of more advanced topics: multiple regression, multiple and partial correlation coefficients, discriminant functions, small-sampling distributions (t, χ^2, F, the range, etc.), non-parametric methods (the theory of runs, the Wald–Wolfowitz treatment of serial correlation), χ^2 and tests of goodness of fit, the Neyman–Pearson theory of statistical tests, and the design of experiments (including notes on stratified sampling and sequential analysis). Up-to-date references, exercises both realistic and interesting, the usual tables (together with a very useful one of squares and square-roots) and a satisfactory index complete the work. Of course it is easy to ask for more; one would have liked to see some mention of cumulants, of the characteristic function, of Fisher's exact test for 2×2 tables, and a more adequate account of maximum likelihood estimation. But the author was probably wise in not overloading the book; it will leave many readers full of a most healthy curiosity.

David G. Kendall

Tables de constantes et données numériques

1 : Constantes sélectionées, Longueurs d'onde des émissions X et des discontinuités d'absorption X. Par Y. Cauchois et H. Hulubei. Pp. 200. (Paris : Hermann et Cie., 1947.)

SINCE the publication of Siegbahn's "Spektroskopie der Röntgenstrahlen" no authoritative list of wave-lengths of X-ray emission lines and absorption edges has been published. Cauchois and Hulubei have performed a praiseworthy task in presenting these data in one volume ; they give the wave-lengths in order of increasing magnitude, values of ν/R and $\sqrt{\nu/R}$, and references to original sources. An additional table gives the values for non-diagram lines (which are probably due to transitions in multiply ionized atoms), and an appendix gives the data for each element arranged in order of atomic number.

It will be seen that the book is of interest mainly to X-ray spectroscopists, and for their convenience simple multiples of the wave-lengths are also inserted in the main table. These are described as higher orders, which means that they are the wave-lengths that would be deduced if the observed lines were taken as first-order diffractions.

The authors have chosen the results of particular researches for inclusion in their tables, rather than the means of recent determinations. It is difficult to see the justification for this, when many workers have produced results of comparable accuracy. Some discussion of the whole question of accuracy would have been valuable, since X-ray crystallographers have tended to accept data given to any number of figures. It is pleasing to note that the authors have not given any *real* values (that is, first orders in their notation) to more than six figures, so that, for example, CuKα appears as 1537·40 X. instead of the usual 1537·395 X. ; but one would have welcomed more discussion of this question of accuracy.

H. LIPSON

Experimental Embryology in the Netherlands, 1940–1945

By Prof. M. W. Woerdeman and Prof. Chr. P. Raven. (Monographs on the Progress of Research in Holland during the War.) Pp. xi + 132. (New York and Amsterdam : Elsevier Publishing Co., Inc., 1946.) 6.50 fl.

THIS small volume was prepared by Profs. Woerdeman and Raven during the last months of the War, with the purpose of presenting as soon as possible an account of the work which had been done in experimental embryology during the German occupation, and which had therefore remained either unpublished or at least unknown to men of science of the Allied nations. When one considers the difficulties under which the work must have been done, the record is a remarkable one. The group at Utrecht under Raven has made an intensive study of the egg of *Limnea*, a representative of the so-called 'mosaic' eggs which have been rather unfashionable experimental material in recent years. Their careful histochemical study of the process of maturation, and their description of the different plasms and their behaviour after centrifugation, may be expected to direct the attention of students of general cell physiology to the extraordinary but fascinating phenomena to be seen in the cytoplasm of egg-cells. In Woerdeman's laboratory, work has been mainly on the more classical object of the Urodele egg. Perhaps the most striking new line of attack is that opened by experiments of ten Cate in which he has shifted the time of embryonic determination relative to that of anatomical development.

Elsevier's Encyclopædia of Organic Chemistry

Edited by E. Josephy and F. Radt. Vol. 14 : Tetracyclic and Higher-Cyclic Compounds, Series 3 : Carboisocyclic Condensed Compounds. Pp. xx+711. (New York and Amsterdam : Elsevier Publishing Co., Inc., 1940.) n.p.

IT is impossible to give a critical review of what, after all, is a dictionary or catalogue.

The volume at present under consideration covers all condensed-ring hydrocarbons, sterols, bile acids, sex hormones, heart poisons and sapogenins. It is claimed that the literature is covered up to the end of 1936 ; but in fact the book also contains many later references, going as far as 1939. We are informed that periodical supplements are to be published, and these will doubtless bring the references up to date.

The related compounds are also found in tabular summaries or charts showing their interrelationship and methods of formation. There is an excellent formula index, as well as a very complete subject index containing even such compounds as desoxytetrahydroanhydrodigitoxigenin.

From the production point of view the volume is excellent ; the formulæ are very clearly drawn and the text is easy to read.

The book should be of great assistance to sterol chemists, especially those who have no access to a modern edition of Beilstein. It is a convenient source of reference to a large number of organic compounds, thus saving much time spent in searching through Beilstein and numerous abstract indexes.

The present volume is No. 14, and the price of this is quoted as in the region of 60 dollars. Subscription to this series is therefore no light matter.

Functions of a Complex Variable

By Prof. Thomas M. Macrobert. Third edition. Pp. xv+390. (London : Macmillan and Co., Ltd., 1947.) 18*s*. net.

IT will be recalled that this volume first made its appearance in 1917. After a reprint in 1925, a second edition followed eight years later, and this was also reprinted in due course. It contained a considerable amount of additional subject-matter, occupying some fifty pages, mainly devoted to the study of special functions, and it is interesting to note that a reviewer at the time described it as a book in which the student would find just the material he required, clearly set out and with sufficient rigour for his needs, without delving too deeply into abstract theory.

No greater justification of this statement and no more convincing proof of the usefulness of the book to students of the theory of functions could be provided than the fact that the production of yet another (the third) edition has taken place in such a short space of time. On this occasion the author has again extended the scope of the work by a further twenty pages, constituting an appendix on generalized hypergeometric functions, together with another set of miscellaneous examples. Apart from these additions, the contents are identical with those of the second edition. In spite of present-day austerity, the book is well bound and clearly printed, and it seems natural to suppose that it will continue to enjoy a well-earned popularity.

J. H. PEARCE

FUNDAMENTAL PHYSICAL THEORY

CONFERENCE AT BIRMINGHAM

PROGRESS in physical theory has from time to time come to a standstill during periods in which the theory has become increasingly complex and incapable of accounting for the observed phenomena, and which have eventually been resolved by the emergence of a fundamentally new idea. Examples of such new ideas are the electromagnetic theory of light, the older quantum theory, the principle of relativity and the new quantum mechanics. The present is again a time of failure of physical theory. The impasse has lasted about ten years, but the required new idea is still lacking. It was against this background that an informal conference on fundamental physical theory was held in Birmingham during the period July 23–26. About eighty people attended, of whom some thirty came from outside Great Britain.

The discussion at the first session was opened by Prof. R. E. Peierls, who gave a review of the difficulties associated with infinite self-energies and of the attempts that have been made to overcome them. This topic occupied the conference for the first two half-day sessions, and was resumed at the final session on July 26, which had been left free from agenda. Already in classical electrodynamics infinite self-energies occur if it is assumed that electrons and protons are point charges; but with the development of quantum theory it had been hoped that they would disappear, as had other difficulties of classical physics. Such hope has proved unfounded, and, in fact, quantum electrodynamics introduces new infinities connected with fluctuations of the electromagnetic field.

Recent attempts at removing these difficulties, none of which has proved satisfactory, fall into two classes: those which try to give a consistent formalism leading to finite results without introducing a fundamental length into the basic field equations, and those that do.

Foremost in the first class is the theory of Dirac involving the so-called λ-limiting process and introducing an extra field of redundant variables. Dirac succeeds in putting into Hamiltonian form equations which in the limit give the equations of electrodynamics, free from infinite terms. The equations can be translated into quantal terms in the usual way, and when supplemented by the redundant variables, which in a formal way correspond to negative-energy photons, give rise to no divergent integrals when solutions are sought by the usual perturbation methods. The detailed physical interpretation of the formalism is not unique, but to the simpler problems it gives unambiguous answers in agreement with observation. A feature of the equations of motion of point charges is that they possess 'runaway solutions' in which the particle accelerates asymptotically towards the velocity of light. They do not correspond to real motions and can be eliminated, at least in the classical version of the theory, by postulating extra boundary conditions of an unusual type (final, as opposed to initial, conditions); but in the quantal theory this cannot be done so simply, and a difficulty appears to persist.

Along rather similar lines is the application by Gustafson and Fremberg of an analytic method of dealing with hyperbolic differential equations developed by M. Riesz. In classical theory it leads to the same results as the λ-limiting process. The application to quantum theory is claimed to give useful results; but several objections were raised in the discussion to Gustafson's arguments.

The difficulties with infinities appear to be characteristic of field theories. Attempts to avoid the field concept and revert to an action-at-a-distance description are therefore attractive. One such theory of interest has recently been proposed by Wheeler and Feynman. It involves the propagation of influences backwards, as well as forwards, in time; but with the help of a plausible assumption, namely, that all radiation emitted will eventually be reabsorbed somewhere in the universe, it can be shown to be equivalent to the field description. Although no complete quantal version of the theory exists, it was felt by several members of the conference that it would meet with essentially the same difficulties as field theory, and objections (albeit inconclusive) were raised against it on the grounds of conflict with the quantal theory of observation.

Another attempt at avoiding infinities, due to Heitler, is the so-called radiation damping theory which prescribes rules for ignoring infinite terms arising in the calculation of radiative processes by perturbation methods. Arguments were put forward during the discussion to show that the neglect of these terms in the calculation of the energy implies neglecting terms which are essential in obtaining correct answers to other problems, notably the emission of soft radiation in *Bremsstrahlung*, as pointed out by Bethe and Oppenheimer, and the propagation of light with finite velocity. A precise formulation of the rules is, in any event, lacking; they imply a division of photons into 'real' photons, and 'virtual' photons associated with the near field of a charge, a division which cannot be made unambiguously within the framework of the present theory.

It is theoretically possible to construct a field theory in which the self-energy of a singularity is negatively infinite. If it is assumed that in addition to the electromagnetic field such fields are set up by charged particles, and that they fall off very rapidly with distance so as to be negligible at atomic distances, it is possible to construct a theory which reproduces the observed forces between particles on the atomic scale, and which by suitably choosing the coupling constant of the new field cancels out the positive with the negative infinity. Such theories have been studied by Bopp, Stueckelberg, and more recently and in greater detail by Pais. Proceeding by perturbation methods, Pais has shown that the infinities in the terms up to second order can be eliminated; but it is not clear whether this holds for higher orders.

Various attempts at interpreting the results of the equations as they stand were discussed at the conference, such as by calculating finite differences between the energies corresponding to different states and similar methods. Peng has, in fact, recently claimed to show that the infinities arise from the approximation methods and are not inherent in the theory; but there are flaws in Peng's argument and his contention has been abandoned. The underlying idea of the finite difference method is the convergence of a series (or integral) formed by the difference of two series which themselves diverge; if there is a unique correspondence between terms, such a sum may be expected to have a physical meaning; but in most cases the correspondence is ambiguous and

often even the difference is divergent. Particular interest attached to a letter from H. A. Bethe who had in this way calculated a correction to the fine-structure separation of the hydrogen levels in the direction indicated by the microwave observations of Lamb and Retherford.

An early theory of the fundamental length type is the non-linear electromagnetic theory of Born and Infeld. Its practical consequences are so difficult to calculate that it is not possible to say that it has been disproved, although one would prefer a simpler description of phenomena. Another approach is to introduce a 'structure factor' for electrical particles, which can be done without conflicting with the principle of relativity only by assuming that the charge density at a given time depends on the position of the particles at other times. Such a theory can be made to avoid the classical infinities and probably the runaway solutions, but no quantization has yet proved feasible.

A more fundamental change of view is contemplated in a series of papers by Snyder, who considers a 'quantized' space-time. In his theory the space and time co-ordinates are non-commuting quantities, the eigen-values of the space co-ordinates being discrete (the interval between them thereby introducing a fundamental length). The idea still needs further development; but is indicative of the radical departure from our present ideas which may be necessary.

One session was devoted to mesons. There are so many variants of the theory that it is difficult to speak of agreement with experiment, but in general it seems to be poor for scattering and *Bremsstrahlung* processes. The agreement is insufficient to indicate the value of the meson spin. That negative mesons stopped in carbon and other light elements have time to decay into electrons before being captured by carbon nuclei is an experimental result which challenges the theory. According to calculations of Fermi, Teller and Weisskopf, it is in conflict with the meson theory of nuclear forces; Bohr, on the other hand, has criticized their argument and suggests that there is no disagreement. Dr. Ferretti reported on more comprehensive calculations, which show how complicated the process of the stopping of mesons really is, and which, while very provisional, do indicate a conflict with experiment, though smaller than calculated by Fermi *et al.*

Our knowledge of mesons is still so incomplete that we do not know how many different kinds exist, nor with certainty from what particles they can be formed and into which particles they disintegrate. A report on the recent observations by the Bristol group, of mesons 'disintegrating' into other mesons, probably with the emission of another unidentified particle, and of mesons causing nuclear disruptions, was of interest in this connexion.

Two sessions were devoted to nuclear theory, including the meson theory of nuclear forces. Consequences of this theory can only be calculated quantitatively for the simplest nuclei, and agreement with experiment is poor in view of the number of variants. The theory suffers from the infinities of all field theories, which here lead to greater difficulties than in electrodynamics. There were reports on calculations of magnetic moments, photo-disintegration of the deuteron, scattering of protons and neutrons and the effect of 'tensor forces', which, generally speaking, gave vague support for certain specializations of the theory. It was clear that the time is not yet ripe for detailed calculations on complex nuclei, although one may profitably study such problems as the possible rotations of heavy nuclei, which involve only general considerations, and the regularities of nuclear spins, which are zero for all nuclei containing an even number of protons and of neutrons.

The conference was throughout kept on an informal level and owed much of its success to the organisation undertaken by members of the theoretical physics department of the University of Birmingham, and to the hospitality of the University, which not only gave financial aid, allowing distinguished physicists from abroad to be invited, but also entertained to dinner all members of the conference on the evening of July 25. The conference provided an ideal opportunity for the interchange of ideas, such as is often absent from a more formal conference, even though it made abundantly clear that the fundamental idea essential to further progress in physical theory is still lacking.

M. H. L. Pryce

THE WORLD FEDERATION OF SCIENTIFIC WORKERS

By J. G. CROWTHER

THE World Federation of Scientific Workers was founded in July 1946. It is a natural outcome of the growth of science, and of the scientific profession, in many countries. Associations of scientific workers concerned with the problems of scientists as scientists in general, rather than specialists in a particular technique, began with the foundation of the National Union of Scientific Workers in the United Kingdom in 1918. This body was originally a trade union; but it relinquished this status for about two decades, resuming it in 1941. Its name is now the Association of Scientific Workers, and it has more than eighteen thousand members. The success of the Association, with its young and widely varied membership, has made a deep impression in many countries overseas. Consequently, when the Association took the initiative in proposing a world federation of similar bodies, it found an enthusiastic response.

The World Federation of Scientific Workers already contains seventeen affiliated bodies in fourteen countries from all five continents. It is able to call on a very wide range of experience for advice.

The fundamental aim of the Federation is to strengthen the mutual aid and information between scientists in every country, so that the strength of the scientists in one country shall be the strength of all their colleagues throughout the world. It is hoped to further through the Federation the achievement of agreed opinions on those questions which affect all scientists alike, irrespective of their speciality. In this way the scientists of the world will be able to speak with one voice on matters that affect them fundamentally. Towards this end the Federation is preparing a Scientists' Charter, defining the duties and rights of scientists, which should be observed in all countries. In every place, it will be possible to compare the actual situation with that given by the Charter, and thus assist scientists everywhere with a guide to a proper status for science and scientists. The standards of education, remuneration, working conditions, opportunities for work, and the control

and direction of science vary greatly over the surface of the globe. Scientists have special knowledge of science, and in virtue of this they have the responsibility of seeing that the public is correctly informed on scientific matters which affect public affairs.

The World Federation seeks to keep in touch, and collaborate, with other international bodies concerned with science, such as the United Nations Educational, Scientific and Cultural Organisation, and the World Federation of Trade Unions. U.N.E.S.C.O. has already invited the Federation to send an observer to one of its panels, and it has invited the Federation to send an observer, subject to confirmation by the Conference itself, to the present U.N.E.S.C.O. Conference at Mexico City.

Another direction in which the World Federation has been able to contribute towards international understanding between scientists is in collaboration with other scientific bodies in the commemoration of scientific personalities and events of international significance. It joined with the Association of Scientific Workers and the Society for Visiting Scientists to organise meetings in memory of Paul Langevin, and it has joined with the Association des Travailleurs Scientifiques and the Syndicat National de l'Enseignement Supérieur et de la Recherche Scientifique in organising, under the patronage of the President of the French Republic and the Académie des Sciences, a meeting in Paris in commemoration of the tenth anniversary of the death of Lord Rutherford. The occasion will be an opportunity for remembering the great physicist, and reflecting on what has come of his work, and that of his colleagues in physics. A special feature of these meetings is that they have been organised primarily by the scientists of one country in celebration of the achievements of a scientist of another country, and have thus contributed towards the strengthening and understanding of mutual dependence and sympathy in science.

The president of the World Federation of Scientific Workers is Prof. F. Joliot-Curie, and its registered headquarters are in Paris. French-speaking inquirers can most readily receive further information about the Federation from the Secrétaire Général, 47 Boulevard St. Michel, Paris V, and English-speaking inquirers from the Secretary-General, 15 Half Moon Street, London, W.1.

THE PAINT RESEARCH ASSOCIATION

By Dr. L. A. JORDAN
Director

THE co-operative industrial research association movement in Britain is an interesting development, whatever may have been said or written about it, particularly during the last few years. Those responsible for controlling the work of the associations and of holding together on a voluntary basis a heterogeneous membership with varied views as to what co-operative industrial research is about, are conscious of the limitations and have no illusions about the weaknesses of the system. They have the responsibility of watching the interests equally of all their members; no duty could be more difficult, and errors of judgment are not lightly tolerated. Displeasure, however transient, saps enthusiasm, without which nothing is achieved; on the other hand, confidence is a plant of slow growth, but it is essential and it can be won.

One must admit that the crux of the matter, or at least one aspect of it, is the interpretation placed by individuals on the word 'co-operative' and how it is related to the primary and universal human instinct of self-interest—which may come to be regarded as self-preservation. Research work is not the only human activity in which it must be recognized that there are degrees in co-operation, and that it does not do to strain even the best of good intentions. Fortunately for research association work, many industries have a wide background of technology waiting for first-class scientific investigation from which information may be gained acceptable to all, provided it is brought only to a certain stage. That stage is when each member firm according to inclination and capacity can take the material information offered and develop it within the ambit of the firm's interest.

Inevitably that stage is too far for some—or at least they think so; definitely not far enough for others, and certainly not far enough to ensure a widespread, rapid and effective absorption of research results into the technical administration of the industry. How to deal with that problem may give rise to differing opinions and to much honest doubt. The uneasiness so frequently expressed about the research association movement is justified in so far as it is prompted by concern as to whether means can be found to give a better overall performance, meaning the integration of the results of scientific work plus development plus utilization by the greater part of an industry.

In the meantime, while such problems are being resolved, directors of research associations have to operate the instrument provided and, coming down to a homely metaphor, the 'proof of the pudding' test still holds. If one is so minded, many quite logical and apparently sound reasons can be found why the research association idea should not work out in practice; but, in fact, the associations have not done too badly. As with most human enterprises, everything turns upon the degree of satisfaction accorded to the participants, not the least important, particularly in time of war, being the State. It is true to say that had the research associations not existed in 1939, Britain would have lacked a very powerful weapon; for the associations made it possible to mobilize at short notice in industry by industry most of the scientific and technical knowledge available, and they provided facilities for the immediate investigation of new problems under most favourable conditions.

In a number of cases, particularly those concerned with the traditional industries, associations were not easy to start; thus it was not until 1926, that is, ten years after the movement began with the establishment of the Department of Scientific and Industrial Research, that the Paint Research Association was formed. The term 'paint' in this context includes colour (that is, pigments), varnish, printing ink, certain aspects of linoleum—in fact, all those procedures which depend upon a related technology of incorporating a solid into a fluid medium.

It is pertinent to ask what the Association has done during its twenty-one years and what it proposes to do—two questions which can be taken together in so far as they can be dealt with adequately in this short statement. First, there has been too

great a tendency to judge research associations by the flashing discovery that solves all problems. That sort of thing is good publicity while it lasts, but is erratic in its incidence; and industries vary in the opportunities they provide for that type of work. Even so, the impression left on the collective business mind is not likely to be as lasting as the proud inventor thinks is justified.

The real need is to make and hold satisfied customers who tell their friends, and that means good nourishing fare, regularly supplied; if some special treat can be provided occasionally, so much the better. The rhythm of the Paint Research Association has been steady rather than spectacular. Much diffused information on many subjects has been brought together and records annotated, interpreted, presented and used with satisfaction. A goodly portion of the scientific background of the industry has been filled in effectively, and thereby some relief has been given to the pains of scientific indigestion, arising from the flood of new chemical substances which find uses as bases for paint materials. The volume of investigational work incidental to the provision of substitutes (to use the current phrase), better described as the proper utilization of available materials, particularly during and since the War, has been very large indeed; and some useful items have been discovered in the process. The resources of the Association have been spent, for the most part, in carrying out scientific work in the laboratory on subjects (of which an indication will be given later) arising out of problems, both short-term and long-term, peculiar to the industry.

Many factors have operated everywhere during the last generation to affect the outlook of the paint and related industries; the British industries have been greatly altered as a result of research association activity. No claim is made about monetary savings arising out of the adoption of some specific process, because we have not operated that way; yet it must not be assumed that members of the Association have not benefited financially. Indeed, not a few manufacturers admit to new and profitable procedures having been developed by them as a result of direct advice from the staff, or by utilizing hints and recommendations in technical papers.

Two years ago, a survey of the problems of the paint and allied industries was made which presented a conspectus of the field of interest, with a shorter list of collateral studies in related fields entitled "Investigations at Present Envisaged", on the basis of which work is proceeding as circumstances permit. At the same time, appropriate reference was made to matters which had already occupied the attention of the research staff to such an extent as to have resulted in a technical paper or other publication on the subject. The number of such references is impressive.

It is usual to think of paint in terms of its colour, and that means the pigment which often gives the name to the paint. A solid powder in a liquid does not necessarily make paint, and it is reasonable to accept the view that much of scientific and technical interest is to be found in the conditions operating at the interface between the pigment and medium constituting a paint—such as the wetting and dispersion of pigments, properties which must be evaluated and assessed, or the manner in which the rheological properties and other characteristics of paints are influenced by pigment/medium volume relationships and by physical factors, that is, actual physical form and surface condition, the volume and packing characteristics and the state of flocculation of the pigment. These things, among others, determine the nature of the liquid paint, its behaviour on storage (settlement, skinning, etc.), its behaviour in use (brushing quality, opacity, spreading power, etc.), its film properties (gloss, colour, hardness, resistance and sensitivity to water attack, permeability, rust inhibition, etc.) and durability which in the first instance largely depends upon adhesion to the support. All this is not due alone to interfacial conditions; but they are very important.

The different methods of application of paint and varnish and the nature and preparation of the surface of the material painted (metals, plaster, various woods, and now plastics), the manner and mechanism of film formation, the physical relationships between coats in multiple-coat films and the significance of such matters as threshold film thickness, pigment particle and molecular orientation, are all important aspects of study, as is evidenced by the large number of technical papers and research memoranda issued, approximately 150 of each. A few of these papers, dealing with "Priming of Joinery Timber", "Painting of Plaster" (from the Building Research Station), "Painting of Non-ferrous Metals", "Preservation of Iron and Steel by means of Paint", have been available to the general public. Perhaps the most notable contribution of the Paint Research Association to public papers is the book entitled "Painting of Buildings", No. 5 in the Post-War Building Series (H.M. Stationery Office); also an important contribution has been made to the Building Research Station reports on the repair of damaged buildings.

In addition to the rather general observations made above about work relating to paints and paint application, there are seven other sections into which the technology of the related industries is divided for convenience in presentation; namely, oils, varnishes and resins, pigments and chemical colours, cellulose and other lacquers, testing, bitumens, blacks and pitches, and anti-corrosion.

Oil to the paint industry, of course, means the natural drying oils and mainly linseed oil, which is still, as it has long been, the backbone of the industry. At the present time there is a good deal of publicity being given to the problem of 'substitute linseed oil', which is not an easy problem on the large scale. During the War, great efforts were made to produce, by treatment and manipulation of other oils—castor oil in particular—a product simulating the properties of tung oil; circumstances have now changed and the urge to-day is to simulate the properties of linseed oil by treatment of one or other of the semi-drying oils. The indications are that selective solvents will permit the segregation at reasonable cost of soya bean oil, rubber seed oil or candlenut oil, and possibly others, into two fractions, one rather lower and the other correspondingly higher in iodine value, which is one of the criteria of a drying oil.

In the whole range of the drying oils, including, in addition to the types already mentioned, oiticica and various fish oils, everything depends upon treatment, mainly heat with or without air oxidation. At the far end of the treatment scale, linseed oil becomes linoxyn, the gel which is the primary linoleum base.

There are, of course, partial alternatives to drying oils, namely, materials of petroleum origin and also wool-grease; the contribution of the Paint Research Association in these fields is everywhere acknowledged.

It is most necessary in an article of this kind to avoid the appearance of a catalogue, but there are still several sections of work to which no detailed reference has been made. Nevertheless, maybe sufficient has been said to indicate that the science involved in the study of paint is profound, and that the Paint Research Association is giving it attention.

ADVANCES IN PREVENTIVE MEDICINE DURING THE WAR OF 1939–45*

By Sir ARTHUR MacNALTY, K.C.B.

DURING war-time, the risks to health are many and varied; yet the essential health services of Great Britain were maintained during the Second World War at a high level of efficiency.

Vital Statistics. The estimated mean population of persons of all ages in England and Wales was 41,246,000 in 1939 and 37,785,000 in 1944. There was an addition of half a million older persons during five years of war. The birth-rate, rising from 1941 onwards, reached 17·7 per thousand in 1944, the highest it has been since 1926, and the effective reproduction-rate came within one per cent of a full replacement standard. The death-rates have not notably increased. The maternal mortality-rate fell gradually from 3·10 per thousand total births in 1939 to the low figure of 1·92 in 1944. Through sulphonamide treatment there was a notable decline in deaths from puerperal fever and sepsis. The infant mortality-rate rose a little up to 1941, but thereafter declined, and in 1944 the rate dropped to the record figure of 45 per thousand. An outstanding feature was the low mortality of children from disease during the war years.

Infectious Diseases

Generally, the chief diseases which engaged attention during the War of 1914–18 were watched for and prevented by the same means in the Second World War. These means were the maintenance of the normal health services so far as possible; port sanitary control, which guarded against the introduction of infectious diseases from abroad; purity of the water supplies; notification of infectious diseases; hospital isolation; maintenance of adequate nutrition, etc.

Smallpox. In the six years, 1939–44, 28 cases occurred in England and Wales with three deaths, all in 1944. In Scotland there were three noteworthy outbreaks in 1942, affecting Glasgow, Edinburgh and Fifeshire. Infection of a severe type appears to have been imported from the East on a ship which arrived on May 29 at the Port of Glasgow. In all, there were 72 cases with 16 deaths. The outbreaks were speedily controlled through vaccination of patients and contacts, hospital isolation and disinfection.

Scarlet Fever. The incidence declined in the period 1939–42; it then increased to epidemic proportions in 1943, with some regression in 1944. The low fatality-rate fell still lower.

Measles and Whooping Cough. As a measure of war precaution, notification of measles and of whooping cough became compulsory in England and Wales in 1940. Measles was severely epidemic in England and Wales in 1940 and 1941; a remission in 1942 was followed by a recrudescence in 1944, when the recorded prevalence was 158,479. The deaths in the epidemic years 1940 and 1941 were only 75 per cent of the average number in the quinquennium 1935–39, and the mortality-rate in the war years was unusually low. The recorded figures for whooping cough since 1940 indicate that the incidence of the disease is on the average much less than measles. The death-rates were not unduly high. Serum therapy gives inconclusive results, and vaccine prophylaxis, at present, seems of little avail.

Diphtheria. A striking success was achieved in the prevention of diphtheria, "the killing disease of childhood". Immunization has been encouraged by the Ministry of Health and progressive local authorities for the past fifteen years. In 1914 the campaign for mass immunization was intensified, the Ministry undertaking the free provision of prophylactics. It was roughly estimated that between 55 and 60 per cent of the child population of England and Wales had been immunized. There was a notable decline alike in the incidence and mortality of diphtheria during the war years. In 1940, when systematic immunization began, there were 46,281 notified cases with 2,480 deaths; in 1944 there were 29,949 cases with 934 deaths. Diphtheria is a preventible disease, and steady continuous effort is needed to raise the general percentage of immunized children to at least 75.

Typhus Fever. From times immemorial, typhus fever has been favoured by war conditions. For this reason, the Medical Department of the Ministry of Health took special precautions against the risk of introduction of the disease into Great Britain. The Ministry also issued a memorandum on louse-borne typhus fever, and supplies of anti-typhus vaccines were provided.

During the War, medical research has greatly advanced the knowledge of typhus, its prevention and treatment. The principal method of checking an epidemic is effective delousing of the population at risk. "No lice, no typhus" remains the guiding rule. As is now well known, the new synthetic compound D.D.T. has a toxic effect on lice, mosquitoes and flies. By its use a serious typhus epidemic among the Italian population in Naples and southern Italy was speedily checked. Delousing and vaccine therapy can now speedily control an outbreak. The conquest of this dire disease is one of the outstanding triumphs of the war period.

Cerebro-Spinal Fever. That war favours epidemics of cerebro-spinal fever is due to overcrowding and lack of adequate ventilation in camps and billets, which assist droplet infection, and by movements of troops, which lead to the introduction of fresh and virulent strains of the meningococcus. From the end of 1914 until 1918, cerebro-spinal meningitis was epidemic on an unprecedented scale in Great Britain, the case mortality-rate averaging 72 per [illegible] 1938 I directed attention to the maintained [illegible] of notifications of the disease and the in[illegible] number of Group I meningococcal infections. these reasons I considered it probable that ano[illegible]er period of epidemic prevalence was approaching, a forecast unhappily fulfilled. In 1940 the disease began rapidly to increase and continued to do so into 1941. The total of notifications in 1940 was

* Substance of a Chadwick Lecture given at the Town Hall, Cheltenham, on May 22, 1947.

nearly fourfold that of our previous worst experience in the year 1915. During 1942, 1943 and 1944, the incidence and case-mortality gradually declined. In character the disease displayed its usual severity, and in distribution it prevailed widely. Fortunately, the use of the sulphonamide drugs, and later that of penicillin, in treatment achieved the lowest fatality-rate on record; in some outbreaks the low figure of 4–8 per cent was attained. The annual fatality-rates for the period 1941–44 were, in succession, 19·5, 20·0, 23·6 and 25·6, rates which imply a saving of approximately 15,000 lives. Chemotherapy has provided a powerful weapon against this deadly disease.

Malaria. Based on the work and experience of the First World War, at the outbreak of war in 1939, when the risks of malarial infection from overseas again became imminent, the Ministry of Health had an efficient organisation to hand and an expert staff conversant with the problems that were likely to arise. That these precautions achieved their aim is evident from the insignificant number of cases that occurred. This anti-malarial work has been another triumph of preventive medicine. The outlook for the conquest of malaria is promising. There are new and potent drugs ('Mepacrine' and 'Paludrine') for the prophylaxis and treatment of the disease; the employment of suppressive 'Mepacrine' in highly malarious regions has been effective in maintaining British forces in these areas in a fit condition to fight and defeat the enemy. The infective agent, the *Anopheles* mosquito, can be repelled by D.D.T., which destroys both mosquitoes and larvæ.

Acute Infective Jaundice. Acute infective hepatitis, a virus disease, has caused small outbreaks in Great Britain and extensive outbreaks among the armed forces and civilian populations in Europe and North Africa. The Medical Research Council, at the instance of the Ministry of Health and the Army Council, appointed a Jaundice Committee to investigate the disease; and to facilitate the Committee's work the Minister of Health made 'jaundice' compulsorily notifiable in East Anglia.

Scabies. Scabies had a high and rising incidence in Britain from 1930 onwards. This increase was heightened when war began, first by evacuation and mobilization, and later by overcrowding, industrial shifting of population and shortage of soap, towels, underclothing and bedding, leading to a severe and widespread epidemic of scabies. In 1941 a Scabies Order was made under the Defence Regulations which gave local authorities additional powers to deal with scabies and other verminous conditions. An advisory committee was set up by the Ministry of Health. Many local authorities took vigorous action, established scabies clinics and in some areas, for example, London, the disease was made notifiable. Special investigations were made, as the result of which benzyl benzoate has proved to be the most efficacious application.

Tuberculosis

In the First World War, there was a general rise in tuberculosis throughout Britain. The increase was mainly caused by contact infection, overcrowding and breaking down of bodily resistance to infection by prolonged physical or mental strain. These are difficult things to prevent in war-time. In 1939 the deaths from tuberculosis were 25,623; in 1941 they had risen to 28,670. The figures for the two complete war years do not include soldiers, but there was evidence for a certain increase of the disease among the Fighting Services. The figures of deaths for 1942, 1943 and 1944 showed a decline, being 25,549, 25,649 and 24,163 respectively. The most disquieting feature was that deaths among children from pulmonary tuberculosis and tuberculous meningitis increased substantially during the War. The appreciable general decline has so far been maintained, but the effects in so chronic a disease may appear later. A proportion of the deaths in the non-respiratory form are due to persons drinking infected milk.

At the outbreak of war there was a temporary dislocation of the tuberculosis services in some areas, but excellent work was afterwards done in spite of many difficulties. Evacuation, air-raids, shortage of medical officers, health visitors, nurses and of bed accommodation have all affected the normal service. The scale of rationing was regarded as adequate for the tuberculous if carefully planned as in sanatoria and hospitals. At the invitation of the Minister of Health, a representative advisory committee for tuberculosis was set up, and the Ministry gave special attention to the question of after-care. The Medical Research Council established a committee of investigation, which issued a useful report in 1942.

Recent work on chemotherapy, especially that relating to streptomycin and promin, encourages the hope that eventually a drug will be found which will destroy the tubercle bacillus in man. Miniature or indirect radiography is an important aid to early diagnosis.

Venereal Diseases

War circumstances, as is well known, favour the spread of venereal diseases, and the Second World War was no exception to this rule. The increase was most marked in females. The Ministry of Health encouraged the expansion of diagnostic and treatment facilities, and made a grant to local authorities of 75 per cent of the additional cost. Regulation 33B enabled a medical officer of health, on certain conditions, to arrange for compulsory treatment. Great advances were made during the War in the treatment of venereal diseases. Penicillin has reduced the time required for the treatment of gonorrhœa to a few days, and that for syphilis from a year to approximately ten weeks, though in both these diseases 'following-up' is essential.

Maternity and Child Welfare

Throughout the War, attention was rightly directed to improving as well as maintaining the health of mothers and young children. In the reception areas the existing health services were expanded, maternity homes were improvised, sick bays were set up for minor ailments, residential nurseries for healthy children, and hostels were provided. The existing maternity and child services, on the whole, were well maintained, and the nutrition of expectant mothers and young children was safeguarded by priority allowances of milk, cod-liver oil and vitamin supplements. All this work saw its reward in the remarkable reduction of the maternal and infant mortality-rates in war-time.

Industrial Health

In various ways the health of the industrial worker was safeguarded by the Factories (Medical and Welfare Services) Order of the Ministry of Labour and National Service, by the application of the results of medical research to his protection, and by the

appointment of medical officers and nurses in armament and munition factories. There is still need for the more comprehensive development of industrial health services.

Laboratory Services

To provide a new service where needed and to strengthen existing services, the Emergency Public Health Laboratory Service was established by the Medical Research Council in collaboration with the Ministry of Health. It offered greatly increased diagnostic facilities, soon proved its permanent value and has become an integral part of the public health service of Britain. The Hospital Laboratory Service set up by the Emergency Medical Service promoted and extended pathological facilities to hospitals throughout the country. Of allied interest was the Blood Transfusion Service, controlled by the Ministry of Health and the Medical Research Council, which saved many lives of soldiers and civilians. Otherwise, the air-raid lists of fatal casualties would have been much heavier.

Nutrition

At the outbreak of war, the Ministry of Food was set up with wide executive powers for the purchase, distribution and rationing of food. Rationing was based on the principle that all the essential foods should be equally available to everyone to an extent necessary to maintain health and at controlled prices. During the War a continuous watch was kept on the nutritional state of the people. There were dietetic and clinical surveys, while the Oxford Nutritional Survey, in association with the Ministry of Health and the Medical Research Council, investigated nutritional problems and added to scientific knowledge. On the whole, national rationing worked well in an unprecedented time of great difficulty and has been an important contribution to the maintenance of good health.

Civil Defence

The emergency hospital medical organisation was designed principally to deal with air-raid casualties and to provide for an outflow of wounded from receiving hospitals in the dangerous areas to hospitals in the periphery and to others still more remote. In practice, the method proved highly successful. The emergency hospitals were also used to a large extent to accommodate chronic sick, who were found in shelters and rest centres in the London area, and for people who needed to be evacuated from the coastal areas in view of the possibility of invasion. The Civil Defence organisation of Britain stood up nobly to the enemy's repeated onslaughts. The public health and medical work done by medical officers of health, doctors, nurses, sanitary inspectors, health visitors and others was beyond all praise. For example, the bombardment of water-mains and sewers involved great risk of outbreaks of enteric disease, yet, owing to the precautions taken, no cases of enteric fever occurred which could be assigned to this cause. A high tribute must be paid to the efficiency of the ambulance service and to the courage, zeal and resourcefulness of the drivers, many of whom were young women.

This satisfactory record of national health during six years of war was a great contribution to national defence, for many wars have been lost by disease and pestilence. The conditions, under Providence, which achieved so excellent a result were: (1) the work of organised public health, environmental hygiene and the health services; (2) nutrition; rationing was ably done by the Ministry of Food with expert medical advice, and the advances made in recent years of knowledge of the adequate principles of nutrition were well utilized; (3) the special arrangements for war emergencies, air-raid precautions, the Emergency Medical Service, evacuation, the comprehensive laboratory organisation, the blood transfusion service and other triumphs of administrative and scientific organisation. Finally, the years of the War and those immediately preceding it had seen great advances in medical science, especially in chemotherapy.

NEWS and VIEWS

American Scientific Mission for London

A SCIENTIFIC mission is to be established in the U.S. Embassy in London to direct the exchange of scientific information and personnel between the United States and Great Britain. It will consist of a small group of scientific men and engineers, headed by Prof. Earl A. Evans, jun. Its activities will cover fields of organic chemistry, biochemistry, physics, biology and agronomy. Mr. John R. Steelman, assistant to Mr. Truman, in a letter to Mr. Herbert Morrison, Lord President of the Council, expressed the hope that the United States would set up scientific missions in other countries in the future. Mr. Steelman explained that the establishment of scientific missions was one of the recommendations included in a series of five reports on science and public policy which he had prepared. The principal objects of the U.S. scientific mission in London will be to facilitate the exchange of scientific personnel and information between the United States and Great Britain; to develop and maintain close personal contact with British Government agencies and other research institutions in the United Kingdom; to answer inquiries originating with the United States Government Departments and scientific agencies in the United States with respect to particular developments in Great Britain; and to stimulate exchange of scientific and technical reports.

Prof. Earl A. Evans, who is thirty-seven years of age, has been professor and chairman of the Department of Biochemistry in the University of Chicago since 1942. He is already known in Great Britain, for he worked at Sheffield during 1940–41 while holding a Rockefeller fellowship, and he is a member of the Biochemical Society of Great Britain. Educated at Johns Hopkins University and Columbia University, he joined the staff of the University of Chicago in 1937 as an instructor of biochemistry. He has carried out work on the chemistry of insulin, the intermediary metabolism of carbohydrates, and radioactive isotopes.

University College of Wales, Aberystwyth

CELEBRATIONS to mark the seventy-fifth anniversary have taken place in the University College of Wales, Aberystwyth, and have included the inaugural

lecture of the session and a commemoration service, as well as a series of gatherings for athletic and social activities. The College was founded by men of great vision and faith whose first meetings were held in London in 1869 in Mitre Court and in the Freemasons' Tavern off Fleet Street. They decided to launch a scheme for the foundation of the University of Wales, and in October 1892 the present College at Aberystwyth was opened in a building designed as a hotel and beautifully situated on the shores of Cardigan Bay. Under the principalship of the Rev. Thomas Charles Edwards, twenty-five men students took arts courses; to-day there are more than 1,100 men and women in the College, drawn from all parts of England, Wales and overseas, reading science, arts, music, law and rural science. The hotel buildings have long since proved inadequate, and with the help of many private donors, the College now owns a site totalling about 400 acres, including the Welsh Plant Breeding Station, and adjacent to the National Library of Wales.

The large and distinguished gathering of old students who returned for the seventy-fifth anniversary is a testimony to the widespread influence of their *alma mater*, and there can have been few occasions when one building held such a constellation of principals and vice-chancellors as that which gathered on October 25 for the presentation of degrees, *honoris causa*. The graduands included Sir James Irvine, principal and vice-chancellor of the University of St. Andrews, and Sir Hector Hetherington, principal and vice-chancellor of the University of Glasgow, both of whom delivered addresses during the celebrations. On October 26, the commemoration service concluded with a requiem for members of the College who gave their lives in the Great War. The music, written for the occasion by the present principal and the professor of music, was sung by the College choir.

Association of British Science Writers

THE Association of British Science Writers was formed on March 3. Its aims are to explain science to the general public; to further the special interests of science writers; to afford the necessary protection when required; to enable science writers to act as a body; to provide facilities, as desired by the members, for general meetings with useful persons possessing material or knowledge of general interest to the Association, or whose interest in the Association is beneficial to its aims and interests; to act, perform or prosecute any other activities from time to time, as and when considered necessary by the members or appointed committee. Membership is open to journalists in the United Kingdom who are bona fide science writers, that is, those who write about science through the media of the Press, dailies and weeklies, journals, magazines and books, etc., and who earn the major part of their income from science writing. The chairman is Mr. J. G. Crowther, science correspondent of the *Manchester Guardian*; and Mr. Maurice Goldsmith, science editor of *Reynolds News*, is the honorary secretary and treasurer. Sir Richard Gregory is the first honorary member of the Association because of the great work he has done in popularizing science. The Association also aims at setting up an associate membership to include those scientists who write regularly about science, but who do not earn the major part of their income from this activity.

Research on Toxicology

THE following have been appointed by the Medical Research Council to serve on a new committee to advise and assist in the promotion of research in toxicology, with particular reference to industrial hazards: Prof. G. R. Cameron (*chairman*), Prof. J. H. Gaddum, Dr. Donald Hunter, Dr. F. C. MacIntosh, Dr. E. R. A. Merewether, Prof. R. A. Peters, J. Davidson Pratt, Dr. J. R. Squire, Dr. J. Walker and Dr. J. M. Barnes (*secretary*).

For carrying out experimental work within the field covered by the Committee, the Council has recently established at the Chemical Defence Experimental Station at Porton (Wilts), by arrangement with the Ministry of Supply, a new Toxicology Research Unit under the direction of Dr. J. M. Barnes. For clinical investigations in this field the Council already has a Department for Research in Industrial Medicine at the London Hospital, under the direction of Dr. Donald Hunter, and an Industrial Medicine Research Unit at the Birmingham Accident Hospital, under the direction of Dr. J. R. Squire. In appropriate circumstances, research in the subject may be promoted by the Council elsewhere, either within its own staff organisation or by means of grants to independent workers.

Soil Surveys in the Caribbean

AT the second session of the West Indies Conference, which met in St. Thomas, Virgin Islands of the United States, in February–March 1946, the question of soil surveys in the Caribbean was considered. With the object of obtaining advice on the recommendation, the Caribbean Commission, of which the West Indies Conference is an auxiliary body, appointed a sub-committee of soil scientists representative of French, Netherlands, British and United States territories of the Caribbean and comprising Dr. H. J. Page, principal of the Imperial College of Tropical Agriculture, Trinidad (*chairman*); Mr. D. Blanche, acting head of the Agricultural Service, Martinique; Dr. J. A. Bonnet, head of the Soils Department, Agricultural Experiment Station of the University of Puerto Rico; Prof. F. Hardy, professor of chemistry and soil science, Imperial College of Tropical Agriculture, Trinidad; Dr. H. J. Müller, agricultural chemist, Department of Agricultural Economics, Surinam.

The sub-committee recommended that a Conference of Soil Scientists should be held in Puerto Rico in 1948, under the auspices of the Committee on Agriculture, Nutrition, Fisheries and Forestry of the Caribbean Research Council, for the purpose of studying systems and methods of classification and mapping of tropical soils, with special reference to the standardization of such systems and methods for use in soil surveys throughout the Caribbean region, and to carrying out such surveys as soon as possible. The proposed agenda is: (i) Presentation and discussion of collected data on soil-forming factors of the various territories. (ii) Standardization of field and laboratory methods of soil surveys. (iii) Discussion of different systems of soil classification and mapping. (iv) Formulation of a detailed regional programme of soil surveys. (v) Survey of problems of soil erosion, soil conservation and soil renovation in the different territories. (vi) Practical application of soil surveys to land utilization. It was recommended that attendance at the conference should be as representative as possible, and should include soil

scientists who are specially interested in tropical soils from the above-mentioned points of view, not only from the Caribbean, but also from other countries; special reference was made to Cuba, Haiti and the Dominican Republic, and it was recommended that the Governments of these countries should be invited to send representatives to participate in the conference. The recommendations have been approved by the Caribbean Commission, and a working committee has been set up to prepare for the conference, the date of which has not yet been definitely fixed.

The Giant Panda

It has been announced by the Chinese Government that the Szechwan Provincial Government has limited the catching of pandas to one pair every five years. This regulation was made at the request of the Academia Sinica with the view of protecting this rare species from extinction. Few mammals have caused more scientific and lay interest than the giant panda (*Ailuropoda melanoleuca*, David), first made known to science when David sent skins home to France from his travels in western China during 1868–69. Several expeditions attempted to secure live specimens, and in 1937 one was exhibited by the New York Zoological Society, and in the following year another was shown in London. Their similarity to the true bears is not borne out by the skull, which resembles the racoons, and thus the sub-family Ailurinæ of the racoons (Procyonidæ) was created for the giant panda and the more numerous lesser panda (*Ailurus fulgens*). It is to be hoped that the lead by the Chinese Government will encourage other Eastern States to curb the activities of collectors, who are likely to exterminate animals of limited distribution.

Education and Training of Laboratory Technicians

A Committee on the Education and Training of Laboratory Technicians was set up by a conference convened in 1946 by the Association of Scientific Workers, the Association of University Teachers and the British Association of Chemists. Among the bodies now represented on it are the Institute of Physics, the Royal Institute of Chemistry, the Biological Council, the Institute of Medical Laboratory Technology and the Science Masters' Association, in addition to the three Associations that convened the conference; there are also representatives of industry and a number of senior laboratory technicians on the Committee; representatives of other organisations concerned with the problem, including the Ministry of Education, are being co-opted. The chairman of the Committee is Prof. F. R. Winton and the honorary secretary is now Dr. H. J. T. Ellingham (secretary, Royal Institute of Chemistry). The attention of the Committee has been directed essentially to that important class of technicians, which includes laboratory stewards and, at the highest level, laboratory superintendents, whose work is vital to the maintenance and operation of research laboratories in industrial organisations, research associations and academic institutions and of laboratories for the instruction of students in universities, technical colleges and schools. Their work involves experience of techniques derived from a number of branches of science and technology; most of them are to be regarded not as potential chemists, physicists, biologists, etc., but as potential first-class laboratory technicians. So far, however, few courses have been provided for the training of technicians of this type, nor is there any qualification in their own field to which they may aspire. The Committee is therefore engaged in preparing syllabuses for the certificate and diploma stages of a general course of training for such laboratory technicians, based on proposals put forward by a sub-committee consisting of the laboratory technician members of the Committee. It is hoped to start a trial course early in 1948. In the meantime, it is understood that a representative group of laboratory technicians who have been associated with the work of the Committee are taking steps to constitute a professional qualifying body similar in many respects to the Institute of Medical Laboratory Technology.

Thermo-nuclear Reactions under Terrestrial Conditions

The possibility of initiating thermo-nuclear reactions under terrestrial conditions is discussed by Dr. J. H. J. Poole (*Proc. Roy. Dublin Soc.*, **24**, 71; 1946). It is pointed out that the results obtained by Atkinson, Gamow and Teller, Bethe and others, in their investigations of thermo-nuclear reactions as applied to stellar conditions, are equally valid for terrestrial conditions. In applying these results to the sea, which is the largest known source of thermo-nuclear energy on the earth, four types of reactions need to be considered. They are proton-proton, proton-deuteron, and two forms of deuteron-deuteron reaction. The deuteron-deuteron reaction is shown to be the most important, by comparing the values of the rate of generation of thermo-nuclear energy derived for the several reactions. The question whether it is possible to initiate and maintain a thermo-nuclear reaction in the sea is discussed by considering the case of a sphere of water in which thermo-nuclear energy is being generated and which is radiating as a black-body. It is shown that the minimum radius of such a sphere must be of the order of 3×10^6 km., so that there would seem to be very little danger of starting a world-wide explosion by dropping an atom bomb into the sea. (Dr. Poole's paper was written prior to the Bikini atom bomb tests.) If the sphere consisted entirely of heavy water, the minimum radius is reduced to 3·6 km., so that even in this extreme case a self-maintained thermo-nuclear explosion would be unlikely to be started by an atom bomb. It is probable, however, that if heavy water were incorporated in the bomb, with some of the energy liberated in the explosion being derived from deuteron reactions, more complete fission of the active heavy-element constituent would be ensured by the neutrons emitted by the reaction.

Catalogue of Laboratory Equipment

In the days before the War, the comprehensive catalogues of the laboratory furnishing firms were the 'bibles' of all those concerned with the ordering and purchasing of laboratory apparatus and instruments. The long years of abnormal circumstances and particularly of paper shortages have deprived laboratory workers of these ready and compact sources of information covering the whole range of scientific laboratory equipment. It is therefore heartening as a foretaste of more normal conditions that Messrs. Griffin and Tatlock, Ltd., have been able to issue a new and very substantial catalogue of scientific apparatus, and that the familiar, but out-of-

date, pre-war publication of this firm, which for so long has been indicative of what might once have been obtained, can be replaced by this new list of what is now available. It is obvious from the contents of the catalogue that the scientific apparatus industry of Great Britain has not only completed the transition from war to peace manufacture, but has also expanded its range of products to cover gaps in its production which existed before the War; every article in this most comprehensive list of scientific apparatus is made either by the firm itself or by some other British manufacturer. The catalogue is an attractive publication, and in its arrangement due attention has evidently been paid to the convenience of the user. The catalogue is divided into thirteen sections, each dealing with the apparatus and instruments required for the teaching and experimental work of a particular subject in university and other educational laboratories. In addition, there are a list of chemicals and reagents and a very full index. One very useful aspect of the catalogue is the full description given of many of the items, together with articles on the methods and theory of use. Messrs. Griffin and Tatlock are to be congratulated on this praiseworthy effort.

Publication of Papers on Physics

Prof. E. N. da C. Andrade, in his presidential address to the Physical Society in 1945, referred to the "need of a medium for the publication of original papers on physical problems whose main interest was industrial and technical" (*Proc. Phys. Soc.*, **57**, 21; 1945). To meet this need the Board of the Institute of Physics and the Council of the Physical Society have proposed the introduction of a new journal of applied physics, which, it is hoped, will commence early in 1948. A journal of about 400 pages a year, issued quarterly, is contemplated, devoted to applications of physics, containing papers on original work in technical physics, border-line papers on subjects which are not strictly 'fundamental' physics, reviews of recent advances, discussions, and, probably, editorials, notices of meetings and news items. A Joint Advisory Panel, on which every Group of the Society and all the Groups and local Branches of the Institute will be represented, is to be set up to work out the details. The rate of subscription to the new journal will, at first, be one guinea a year to members of the Society or Institute, and about 30*s*. to non-members.

In his address, Prof. Andrade pointed out also that the increased number of papers communicated to the Physical Society for publication would necessitate issuing two volumes a year of the *Proceedings* instead of the present one. The Council has accordingly announced that, from January 1948, the *Proceedings* will appear in two volumes a year, each consisting of six parts issued monthly, in order that the period between the communication and publication of papers may be reduced. In spite of the title *Proceedings*, a change of which was recently proposed but rejected by the members, papers are published in the Society's journal which are not necessarily a part of the proceedings of meetings. It is felt that, as many Continental physical journals ceased publication during the War and have not yet reappeared, Continental physicists may find a medium for the publication of their work in the Society's journal, now that more space and more rapid publication are assured.

Paper for Technical Journals

Mr. H. Wilson, president of the Board of Trade, replying to Mr. Erroll in the House of Commons on October 30, said that steps are being taken to ensure to journals devoted primarily to original research their full requirements of paper, and he hopes to exempt technical periodicals from the reduction which it is necessary to make in the paper available for periodicals generally.

Breeding of the Moustached Warbler in Britain

Conclusive evidence produced by R. A. Hinde and A. S. Thom (*British Birds*, **40**, No. 4; April 1947) shows that the first recorded breeding of the moustached warbler (*Lusciniola melanopogon*) in the British Isles took place in Cambridgeshire in 1946. The evidence was compounded from observations made by a group of distinguished ornithologists, and the dark crown and superciliary stripe, as well as the cocking of the tail, leave no doubt that this Mediterranean bird, the nearest part of whose normal range is the south of France and whose sole previous claim to a place in the British list rested on a single occurrence, must now be added to the list of birds which have been known to breed in Britain.

Swiss Earthquakes during 1945

This annual seismological report of the Swiss observatories has been compiled by Dr. E. Wanner of Zurich. Seismographs are installed at the Swiss Observatories of Zurich, Chur, Neuchâtel, Basel and Brig, and during the year 85 near earthquakes and 189 strong distant earthquakes were registered. There were ten earth tremors with epicentres in Switzerland which were felt by people during the year. None of these had a greater intensity than V on the Rossi-Forel Scale, so that none reached destructive intensity. The greatest three tremors were (1) May 13 at Freiburg, (2) October 13 at Engadine and (3) November 10 at Wildhorn.

Science in the U.S.S.R.

A symposium on "Science and the Soviet State" in honour of the thirtieth anniversary of the U.S.S.R. is being organised by the Science Section of the Society for Cultural Relations with the U.S.S.R., 14 Kensington Square, London, W.8. The chairman of the meeting, which will be held at the Caxton Hall, London, S.W.1, on November 12, at 6.30 p.m., will be Sir Robert Watson-Watt, and speakers will include Prof. J. D. Bernal on "The Scientist as Citizen", Prof. V. Gordon Childe on "Archæology and the State" and Mr. Andrew Rothstein on "Science and Economic Planning". Tickets for the meeting (2*s*. 6*d*. each) can be obtained from the Society for Cultural Relations.

Medical Sub-section of the Library Association

The inaugural meeting of a new Medical Sub-section of the Library Association was held at Chaucer House on October 4. The following committee was appointed to manage the affairs of the group: C. C. Barnard, London School of Hygiene and Tropical Medicine (*chairman*); Miss E. Wigmore, Medical Research Council; W. A. Lee, Liverpool Medical Institution; W. R. Le Fanu, Royal College of Surgeons of England; T. J. Shields, British Medical Association; G. Wilson, Medical Library, University of Manchester; and W. J. Bishop, Wellcome Historical Medical Museum, 28 Portman Square, London, W.1 (*hon. secretary*).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fractional Precipitation of Serum Proteins

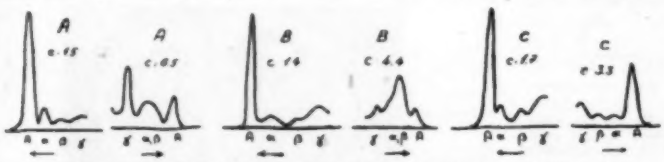
In a recent note[1], we described the purification of renin by means of a fractional precipitation with protein-precipitating agents (sulphosalicylic acid and tungstic acid). In order to test the adaptability of this method, we have investigated the fractional precipitation of blood serum using electrophoresis (Tiselius) for analysing the composition of the products isolated. The most important of the results so far obtained is that it is possible, if we choose the right conditions and suitable precipitating agents, to perform the fractionation with a high degree of selectivity.

(*A*) To 40 ml. ox serum diluted with 40 ml. phosphate buffer (*p*H 7·6) was added 1·22 ml. *M* sodium tungstate and then precipitated with *N* hydrochloric acid until it reached *p*H 6·8. The accompanying electrophoresis curves show a large amount of γ-globulin in the precipitate, considerably less of a component containing α- and β-globulin and only small amounts of albumin. In the filtrate large amounts of albumin, some α-globulin but almost no β- and γ-globulin remained.

(*B*) To 19 ml. ox serum diluted with 19 ml. phosphate buffer (*p*H 7·6) was added 10 per cent sulphosalicylic acid until it reached *p*H 4·0. In the filtrate large amounts of albumin, some γ-globulin but almost no α- and β-globulin remained. The precipitate contained a small amount of albumin, a very large amount of α-globulin, a considerable amount of β-globulin but almost no γ-globulin.

(*C*) To 20 ml. ox serum diluted with 20 ml. phosphate buffer (*p*H 7·6) was added 0·7 ml. *M* uranyl nitrate and solid bicarbonate until the precipitate was again dissolved (about *p*H 8); then *N* hydrochloric acid until it reaches *p*H 6·3. The compositions of filtrate and precipitate are almost identical and correspond to the composition of the original ox serum.

These three examples show the very conspicuous dissimilarity in the products obtained when different conditions and precipitating agents are used. While the uranyl nitrate evidently precipitates the different components to almost the same degree, tungstic acid precipitates chiefly the γ-globulin, and sulphosalicylic acid mainly α- and β-globulin. The only case known to us in which a similar procedure has been used previously is the precipitation of inert proteins from mare serum gonadotrophin by means of sulphosalicylic acid[2] or metaphosphoric acid[3]; but here the bulk of proteins is removed and only a very small amount, containing the active substance, remains in the solution.



FRACTIONAL PRECIPITATION OF OX SERUM WITH (*A*) TUNGSTIC ACID, (*B*) SULPHOSALICYLIC ACID, AND (*C*) URANYL NITRATE. *c* DENOTES THE CONCENTRATION OF THE SOLUTION INVESTIGATED IN RELATION TO THE ORIGINAL SERUM. LEFT-HAND MEMBERS OF PAIRS, FILTRATES; RIGHT-HAND MEMBERS OF PAIRS, PRECIPITATES

By changing the conditions of precipitation (*p*H, salt concentration, dilution, temperature) and the nature of the agents used for formation of the slightly soluble protein compounds, it is possible to modify this method between much wider limits than the methods usually employed in protein fractionation.

This work was aided by a grant from the Teknisk-kemisk Fond; it is being continued and the results will be published elsewhere.

TAGE ASTRUP
AKSEL BIRCH-ANDERSEN

Biological Institute,
Carlsberg Foundation,
Copenhagen, N.
July 15.

[1] Astrup, T., and Birch-Andersen, A., [*Nature*, **160**, 570 (1947)].
[2] Rinderknecht, H., Noble, R. L., and Williams, P. C., *Biochem. J.*, **33**, 381 (1939).
[3] Rimington, C., and Rowlands, I. W., *Biochem. J.*, **35**, 736 (1941).

Constitution of Salmine

It has recently been suggested[1] that salmine may be a cyclic peptide because it does not appear to contain any free carboxyl groups when these are estimated by the methods of Fraenkel-Conrat[2] and Herriot *et al.*[3]. This suggestion is in direct contrast to the findings obtained in the present work, to be fully reported elsewhere. A complete amino-acid analysis of salmine sulphate suggests a molecular weight of 8,000 and a peptide chain of 58 residues:

Amino-acid	Amino-acid *N* as % protein	Amino-acid/100 gm. protamine	Min. mol. wt.	No. of residues	Calc. mol. wt.
Arginine	89·0	85·2	204	40	8160
Isoleucine	0·56	1·61	8140	1	8140
Valine	1·20	3·1	3770	2	7540
Proline	2·29	5·8	1980	4	7920
Glycine	1·78	2·94	2550	3	7650
Alanine	0·56	1·10	8100	1	8100
Serine	3·94	9·1	1152	7	8050
	99·33	108·85		58	7930

The protamine sulphate contains 19·85 per cent H_2SO_4 (40 equivalents per molecule), being sufficient to combine with all the arginine residues in the molecule. The amino-acids reported by Block and Bolling[4] have been confirmed, by isolation as acetyl derivatives; in addition, glycine has been shown to be present in the protamine.

End group analysis by the method of Sanger[5] (Porter, private communication) has shown that proline occupies the terminal imino position. There is no reason to suppose that the procedure of Sanger has resulted in the opening of a cyclic peptide, since a similar procedure carried out on gramicidin-*S*[6] showed that this material was indeed a cyclic peptide.

It seems reasonable to assume that salmine is a normal peptide, and that the methods used by Fraenkel-Conrat and Olcott[1] are not applicable to a protein with such singular properties as salmine.

G. R. TRISTRAM

Biochemical Laboratory,
Cambridge. July 15.

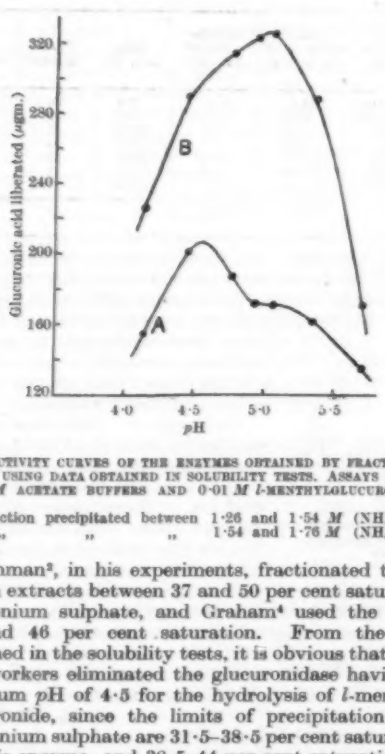
[1] Fraenkel-Conrat and Olcott, *Fed. Proc.*, **6**, 253 (1947).
[2] Fraenkel-Conrat and Olcott, *J. Biol. Chem.*, **161**, 259 (1945).
[3] Herriot, Anson and Northrop, *J. Gen. Physiol.*, **30**, 185 (1946).
[4] Block and Bolling, *Arch. Biochem.*, **6**, 417 (1945).
[5] Sanger, *Biochem. J.*, **39**, 507 (1945).
[6] Sanger, *Biochem. J.*, **40**, 261 (1946).

β-Glucuronidase Activity of Ox Spleen

β-GLUCURONIDASE was first prepared from ox kidney by Masamune[1] and later from ox spleen by Fishman[2,3] and Graham[4]. Each of these workers, using *l*-menthylglucuronide as assay material, indicated that only one glucuronidase was present. Talalay, Fishman and Huggins[5], using phenolphthalein-glucuronide as substrate, came to a similar conclusion.

A re-investigation of the method of preparation and purification of β-glucuronidase from ox spleen revealed that the problem was not so simple as previously indicated. A crude glucuronidase extract from ox spleen was analysed by the 'variable solvent solubility' test as defined by Falconer and Taylor[6] at *p*H 5·0, using ammonium sulphate as precipitant. The results of this test indicated that two protein fractions having glucuronidase activity existed in this crude extract. Similar results were obtained in a test carried out at *p*H 7·0. At *p*H 6·0, however, only one fraction was apparent.

Using the data obtained in these experiments, the crude glucuronidase extracts were fractionated with ammonium sulphate at *p*H 5·0 and the two fractions separated, which on further purification gave the *p*H activity curves shown in the accompanying graph. *l*-Menthylglucuronide and acetate buffers were used in these experiments.



*p*H ACTIVITY CURVES OF THE ENZYMES OBTAINED BY FRACTIONATION, USING DATA OBTAINED IN SOLUBILITY TESTS. ASSAYS USING 0·1 *M* ACETATE BUFFERS AND 0·01 *M* *l*-MENTHYLGLUCURONIDE

A, fraction precipitated between 1·26 and 1·54 *M* $(NH_4)_2SO_4$
B, " " " 1·54 and 1·76 *M* $(NH_4)_2SO_4$

Fishman[2], in his experiments, fractionated the ox spleen extracts between 37 and 50 per cent saturation ammonium sulphate, and Graham[4] used the limits 36 and 46 per cent saturation. From the data obtained in the solubility tests, it is obvious that these two workers eliminated the glucuronidase having an optimum *p*H of 4·5 for the hydrolysis of *l*-menthylglucuronide, since the limits of precipitation with ammonium sulphate are 31·5–38·5 per cent saturation for this enzyme, and 38·5–44 per cent saturation for the enzyme having an optimum *p*H at 5·0.

Preliminary results appear to indicate that the relative amounts of these two enzymes vary in different extracts, rendering inaccurate, therefore, glucuronidase assays using only one *p*H value.

Full details of these experiments will be published later in the *Biochemical Journal*.

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July 1.

[1] Masamune, H., *J. Biochem., Japan*, **19**, 353 (1934).
[2] Fishman, W. H., *J. Biol. Chem.*, **127**, 367 (1939).
[3] Fishman, W. H., *J. Biol. Chem.*, **131**, 225 (1939).
[4] Graham, A. F., *Biochem. J.*, **40**, 603 (1946).
[5] Talalay, P., Fishman, W. H., and Huggins, C., *J. Biol. Chem.*, **166**, 757 (1946).
[6] Falconer, J. S., and Taylor, D. B., *Biochem. J.*, **40**, 835 (1946).

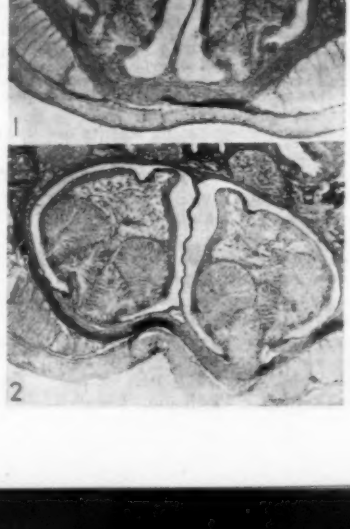
Effect of Thiourea on the Endostyle of Ammocœtes

RESULTS of recent investigations[1–3] have directed attention to a group of drugs which produce hypothyroidism and hyperplasia of the thyroid gland in rats, mice and dogs. These drugs include sulphonamides and various derivatives of thiourea and of thiouracil. Inhibition of amphibian development by thiourea[4] and by thiouracil[5] has been reported.

Like the amphibians, the lamprey (*Petromyzon fluviatilis*) undergoes metamorphosis; on account of this and because the exact function of the endostyle is still a matter for conjecture, a preliminary experiment was carried out to find the effect, if any, of thiourea on the endostyle of the ammocœte.

Four ammocœtes were kept in a solution of 0·033 per cent thiourea in tap water, with mud and waterweed, which was aerated by means of a pump. The solution was changed every day. The animals were killed on the eleventh day. Four other ammocœtes were kept as controls under similar conditions in tap water and killed on the eleventh day. They were all fixed in Bouin's fluid and the sections were stained with hæmatoxylin and orange G.

As a result it was found that in the endostylar glands of the controls there were many vacuoles and the nuclei of the cells were unevenly distributed (Fig. 1); whereas the endostylar glands of the



thiourea-treated ammocœtes showed an absence of large vacuoles and the nuclei were basally placed (Fig. 2).

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June 20.

[1] Kennedy, T. H., *Nature*, **150**, 233 (1942).
[2] MacKenzie, C. G., and MacKenzie, Julia B., *Endocrin.*, **32**, 185 (1943).
[3] Astwood, E. B., *J. Pharm. and Exp. Therap.*, **77**, 79 (1943).
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Stabilization of Penicillin-Salt Solutions with Sodium Citrate

In a recent paper[1], I described the stabilizing effect of sodium citrate dissolved in physiological salt solution on the rate of destruction of sodium penicillin solutions by heat. Only very dilute concentrations of sodium penicillin (1–5 units per ml.) were used.

The present communication deals with the effect obtained with higher concentrations; 100, 1,000 and 3,000 u./ml. were tested and the optimal molar concentration of sodium citrate assessed.

Method. The agar-cup method as described in my previous paper was used. The average of at least three assays was compared with the standard curve constructed daily.

Results. (1) Solutions containing 100 and 1,000 u./ml. sodium penicillin (T.R.C. tabl. 392) were made up with sodium citrate solutions ranging from $M/20$ to $M/600$. The optimal effect was obtained with $M/400$ at *p*H 5·6 and solutions (*a*) in $M/400$ sodium citrate, (*b*) in distilled water adjusted to the same *p*H with phosphate, and (*c*) in one test with distilled water *p*H 4, were heated at 100° C. The results were as follows:

at 100° C.	Percentage of penicillin remaining				
	100 u./ml.			1,000 u./ml.	
after	(*a*)	(*b*)	(*c*)	(*a*)	(*b*)
15 min.	75	75		100	100
30 ,,	60	70	37	80	80
45 ,,	50	35		80	56
60 ,,	25	12·5		80	48

It will be noted that the rate of destruction of sodium penicillin by heat was about the same in (*a*) and (*b*) up to 30 min., but higher in (*c*). After 45 and 60 min. the sodium citrate effect exceeds that of buffered distilled water.

(2) 3,000 u./ml. sodium penicillin T.R.C. 392 dissolved (*a*) in $M/1{,}000$ citrate solution *p*H 6·4 and (*b*) in distilled water adjusted to *p*H 6·3 with phosphate gave the following results after boiling:

	Percentage remaining	
min.	(*a*)	(*b*)
50	65	50
75	48	40
150	17	10

(3) *Stabilization at room temperature.* Ampoules were filled with penicillin salt solutions, then kept at 100° C. for 15 minutes and afterwards at room temperature. The samples remained sterile as proved by several tests for sterility. The solutions contained: (*a*) 10,000 u./ml. sodium penicillin (The Distillers Co., Ltd., Liverpool) (915 units per mgm.) in $M/500$ citrate solution, (*b*) the same in $M/1{,}000$ citrate solution.

	Percentage of penicillin remaining	
after days	(*a*)	(*b*)
21	80	80
28	59	63
35	41	48

A solution containing 1,000 u./ml. sodium penicillin T.R.C. 330 dissolved in distilled water lost 82 per cent of its potency after twenty-five days.

L. Hahn

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[1] *Lancet*, I, 408 (1947).

Microbiological Oxidation of Cholesterol with *Azotobacter*

L. Mamoli and A. Vercellone[1] were the first to work with the microbiological oxidation of sterols. They carried out investigations principally in a series of sex hormones, and with the aid of Coryne-bacteria, cultivated together with yeast, oxidized steroid alcohols to ketones. Recently, G. E. Turfitt[2] found identical results with certain species of *Proactinomyces*.

At the beginning of our work we also used *Proactinomyces*; but we found that the species we isolated were capable only to a small degree of transforming steroid alcohols to ketones (in our experiments, principally cholesterol). We carried out our further investigations with a species of *Azotobacter* and observed the following results:

(1) The transformation of cholesterol to cholestenone was much more successful with *Azotobacter* than with our species of *Proactinomyces*.

(2) Besides the dehydration of the oxy-group, the *Azotobacter* also dehydrates within the sterol ring; thus from the reaction product we succeeded in isolating 7-dehydrocholesterol.

(3) Parallel to dehydration, a stronger oxidation of the cholesterol also took place, as after the process methylheptanone was also formed, from which the splitting off the side-chain could follow.

Our experiments were carried out in the following way. Cholesterol was dispersed in a rich synthetic culture medium of saccharose. The mixture was sterilized and added to the *Azotobacter* culture. A lively fermentation began, which lasted for three–four days, then gradually diminished. On the fourteenth day, after weak alkali hydrolysis, it was extracted with benzene. From the residue of the extract unchanged cholesterol was regained, then the methylheptanone was obtained by vapour distillation. The cholestenone was isolated through its semi-carbazone, and the 7-dehydrocholesterol by chromatographic adsorption.

Our experiments also support the hypothesis[3] according to which 7-dehydrocholesterol in the organism results from an enzymatic action on cholesterol.

The determination of the *Azotobacter* species, as well as the identification of the product formed by the splitting off of the side-chain, are in hand. The experiments also aim at ascertaining the effect the *Azotobacter* species exercises on certain substances of the sterol series.

J. Horváth
A. Krámli

Hungarian Biological Research Institute,
Tihany. July 12.

[1] Mamoli and Vercellone, *Ber. dtsch. chem. Ges.*, **70**, 470, 2079 (1937); **71**, 1686 (1938).
[2] Turfitt, *Biochem. J.*, **38**, 492 (1944); **40**, 79 (1946).
[3] Schönheimer, Behring, Hummel and Schindel, *Z. physiol. Chem.*, **192**, 73 (1930).

A Modified Microbiological Assay Procedure

At a joint meeting of the Biochemical Society and the Society for General Microbiology, the principles underlying microbiological assay were discussed in some detail[1]. The advantages of measuring bacteriological growth directly, thus avoiding the need to pass the lag period before making indirect measurements of growth, such as acidimetry, are offset by the greater complexity of apparatus and technique needed in the more direct ones, such as turbidimetry.

During the discussion at the meeting, I suggested that it might be possible to make the best of both worlds by applying in reverse to the assay of vitamins and amino-acids the principles now very generally adopted for the assay of penicillin and other antibiotics. In other words, the medium would be devoid of the vitamin to be estimated and would be inoculated with the chosen strain of organism, graded amounts of the vitamin being then pipetted into suitably formed cups, using the ordinary Petri dish and agar medium as in the Heatley test and its various modifications. This should result in a circular area of growth round the cup, that is, in a 'zone of exhibition'.

It was not possible to investigate this matter for some time after the meeting mentioned; but Dr. W. F. J. Cuthbertson in these Laboratories has now been able to do so. We find that the zones are, indeed, graded to dose, being over a fairly wide range proportional in diameter to the logarithm of the amount of the test vitamin in the cup. The method seems to work not only for riboflavine and aneurine, on two different media, but also for several other vitamins of the *B* group.

Among the several advantages of this method, which may be of wide application, there are two outstanding ones. In the first place, it puts at the disposal of the microbiological assayist a far wider range of organisms than hitherto, for he is no longer restricted to those that produce acid. This may mean, in effect, that he can bring into use for analytical purposes some of the less-exacting organisms that are known to require only one or two organic nutrients, apart from a source of carbohydrate with the usual mineral salts. The second outstanding advantage is speed, for it has been found not merely possible but desirable to use media and techniques giving maximum growth in less than 24 hours. The Petri dish procedure, furthermore, besides making replication easy, lends itself very well to tests of factorial design with subsequent analysis of variance in their statistical treatment. The chief disadvantage encountered is that, in comparison with the acidimetric technique in test tubes, considerably higher concentrations must be used, and the method as at present carried out cannot be applied to, for example, the estimation of riboflavine in flour and other wheat products.

Further work on the test is in hand, and it is hoped to publish a more detailed account at a later date.

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Sept. 16.

[1] *Biochem. J.*, **41**, 1 (1947).

Escape of Thoron from Thorium X Salts

The absorption method devised by several authors[1,2,3] for obtaining the relative amounts of radium, mesothorium and radiothorium in the mixed salts of these elements in terms of their gamma-ray equivalent has been used for some sixteen sources of this kind destined for a radium mass-unit.

In fifteen of these sources the salts, forming a sphere 5 mm. in diameter and enclosed in a steel tube with walls 1 mm. thick (Fig. 1), emit gamma rays equivalent to 180 mgm. of radium, from which about 34 per cent belong effectively to the gamma rays of radium B + C, 33 per cent to mesothorium 2 and 33 per cent to thorium C + C″.

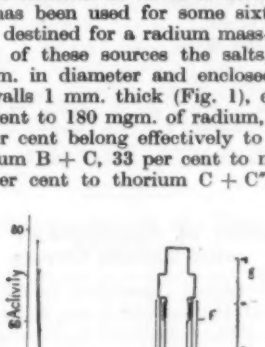

Fig 1

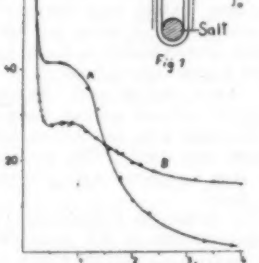

Fig 2

As several of these tubes leaked considerably after they had been sealed, an attempt was made to compare the amount of the escaping radon to that of the thoron by means of their active deposits. We hoped to obtain in this way some information concerning the relation between the parent elements of these two emanations.

In the first experiment the leaky container was exposed for 1 hour in an air-tight vessel (volume 1·5 l.) filled with air at normal pressure. After exposure, the air of the vessel was passed into an evacuated ionization chamber, measured with a bifilar electrometer, and after a total time of 5 min. in the chamber removed and replaced by inactive dry air. The activity of the air amounted to several microcuries.

The residual activity of the chamber after the active air has been removed gave a typical curve (*A*, Fig. 2) of the radon-active deposit of rapid change, with no trace of the thoron-active deposit.

This experiment has been repeated in a different manner. When filling the ionization chamber the air current was passed directly upon the tube with radioactive salts enclosed in a glass tube of slightly larger diameter. With other conditions identical with those of the previous experiments, the residual activity of the ionization chamber (curve *B*, Fig. 2) gave after four hours the well-known plateau of the active deposit of thoron.

In order to find if the thoron is able under normal conditions to escape from the tube at all, a tin-foil (*F*, Fig. 1) was wrapped directly on the tube and left there for 5 min. The activity of the tube was then measured by means of alpha rays. A decay curve

of exactly the same shape as curve *A* was obtained, which is decisive proof that no thoron whatever escapes from the tube containing radioactive salts.

Even with regard to the short half-life period of thoron (54·5 sec.) these results are surprising. They show (1) there is no leakage of thoron from the unsealed radiothorium containers when exposed in the free air; (2) to remove the thoron from the radium–thorium salts a notable difference between the pressure of the surrounding air and of the air enclosed with the salts is necessary.

In the light of these results, the assertions of several workers[4] that there exist atoms of thoron-active deposit in the atmosphere, based only on the measurements of the activity of a negatively charged wire exposed in the free air, need revision.

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Department of Physics,
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July 7.

[1] Hahn, O., *Le Radium*, **11**, 71 (1914).
[2] Bothe, W., *Z. Phys.*, **24**, 10 (1924).
[3] Sievert, R. M., and Olsson, E., *Acta Radiol.*, **12**, 121 (1931).
[4] Meyer, S., and Schweidler, E., "Radioaktivität" (2nd Edit., 1927) 575.

Crystal Structure of Hydroxylammonium Chloride and Bromide

Hydroxylammonium chloride, NH_3OHCl, and hydroxylammonium bromide, NH_3OHBr, are isomorphous and belong to the space group $C_{2h}^5 - P2_1/c$. The unit dimensions are

NH_3OHCl $a = 6{\cdot}94$ kX., $b = 5{\cdot}94$ kX., $c = 7{\cdot}68$ kX., $\beta = 120{\cdot}8°$
NH_3OHBr $a = 7{\cdot}28$ kX., $b = 6{\cdot}12$ kX., $c = 8{\cdot}03$ kX., $\beta = 120{\cdot}8°$

The unit cell contains 4 NH_3OHX.

The structure was determined by means of one-, two-, and three-dimensional Fourier syntheses. In this way it was possible to determine the parameters with great accuracy, but the electron density data were not sufficient to settle the question as to which peaks corresponded to nitrogen and which to oxygen. The neighbourhood of these light atoms and the distribution of the charges support the following choice, exemplified by the chloride:

4 N in 4(*e*) : $x_1 = 0{\cdot}283$, $y_1 = 0{\cdot}664$, $z_1 = 0{\cdot}222$
4 O in 4(*e*) : $x_2 = 0{\cdot}253$, $y_2 = 0{\cdot}870$, $z_2 = 0{\cdot}106$
4 Cl^- in 4(*e*) : $x_3 = 0{\cdot}233$, $y_3 = 0{\cdot}190$, $z_3 = 0{\cdot}395$

Two NH_3OH^+ groups and two Cl^- are thus situated in the immediate vicinity of each of the planes $(\frac{1}{4}\ y\ z)$ and $(\frac{3}{4}\ y\ z)$. This layer structure explains the pronounced cleavage parallel to (100). The distance N—O within the same NH_3OH^+ group is 1·45 kX., which is in rather good accordance with the sum of the covalent radii of N and O.

The closest Cl^- neighbours of a nitrogen atom are at distances of 3·16, 3·21, 3·22 and 3·25 kX. This is comparable with the closest approach between Cl^- and the N atom of the $-NH_3^+$ group in geranylamine hydrochloride[1] (3·17–3·24 kX.), methylammonium chloride[2] (3·18 kX.), and hydrazinium dichloride[3] (3·10 kX.). The distribution of these closest four Cl^- neighbours around the N atom is similar to the corresponding distribution in geranylamine hydrochloride[1] and hydrazinium dichloride[3].

The oxygen atoms have the closest two Cl^- neighbours at distances of 2·98 and 3·04 kX. The closest Cl^-—Cl^- approach is 3·91 kX.

A more detailed report will follow elsewhere.

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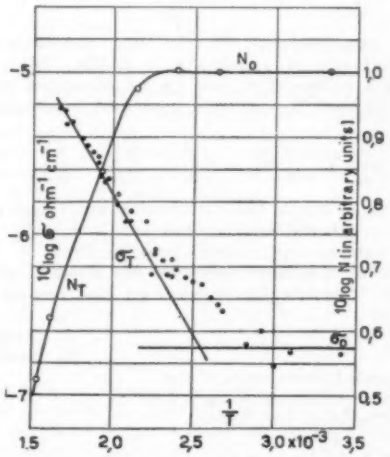
June 26.

[1] Jeffrey, G. A., *Proc. Roy. Soc.*, A, **183**, 388 (1945).
[2] Hughes, E. W., and Lipscomb, W. N., *J. Amer. Chem. Soc.*, **68**, 1970 (1946).
[3] Donohue, J., and Lipscomb, W. N., *J. Chem. Phys.*, **15**, 115 (1947).

Dielectric Losses and Fluorescence of Zinc Silicate

While investigating a manganese-activated zinc silicate, we have found that the temperature-dependence of the dielectric losses and that of the fluorescence (2537 A. excitation) show an intricate connexion. In the accompanying graph there is plotted the logarithm of the total number of light quanta emitted (N) and the logarithm of the electrical conductivity (σ) obtained by measuring the dielectric losses at 20 Mc. (without ultra-violet irradiation) as a function of the reciprocal absolute temperature.



At lower temperatures the fluorescence and the conductivity can be considered as constant (N_0 and σ_0 respectively). At higher temperatures, however, the fluorescence shows a sudden decrease (N_T), while the conductivity (σ_T) increases, giving a straight line in our co-ordinate system.

$$\log \sigma_T = \log A - B/2kT. \qquad (1)$$

In eq. (1), A is practically constant over the temperature-range of our investigations, though theoretically it should be slightly temperature-dependent; B is an activation energy, giving the distance between electron donator and acceptor zones; k is Boltzmann's constant; and T denotes the absolute temperature. Below a critical temperature (approx. 445° K.) the observed conductivity values indicate a deviation from the law mentioned above, showing a gradual transition into the temperature-independent conductivity (σ_0). The resulting conductivity is, therefore,

$$\sigma = \sigma_0 + \sigma_T = c_0 + A \exp.(-B/2kT). \quad (2)$$

The numerical values for our zinc silicate sample are: $\sigma_0 = 0{\cdot}2 \times 10^{-6}$ ohm^{-1} cm.$^{-1}$, $A = 5{\cdot}4 \times 10^{-3}$ ohm^{-1} cm.$^{-1}$ and $B = 0{\cdot}7$ eV.

From these observations, we deduce that the ultimate absorption of the ultra-violet radiation takes place in centres, the number of which is in close relation to the electrical conductivity. Assuming that at temperature T the mobility of the carriers of electricity is the same for σ_0 and σ_T, the total number of carriers is $c_1(\sigma_0 + \sigma_T)$, whereas the number of absorption processes is $c_2(\sigma_0 + \alpha\sigma_T)$, where c_1 and c_2 are constants and α is the absorption coefficient for the σ_T centres, taking the absorption coefficient for σ_0 centres as unity.

The ultra-violet quanta absorbed by σ_0 centres give rise to the emission of the same number of fluorescent light quanta, whereas the absorption by a σ_T centre is non-luminescent. Denoting by N_T the total number of quanta emitted at temperature T, and by N_0 the same at a low temperature, where $\sigma_T \ll \sigma_0$, the temperature dependence of N_T can be expressed by

$$N_T = N_0 \frac{c_2\sigma_0}{c_2(\sigma_0 + \alpha\sigma_T)}. \quad (3)$$

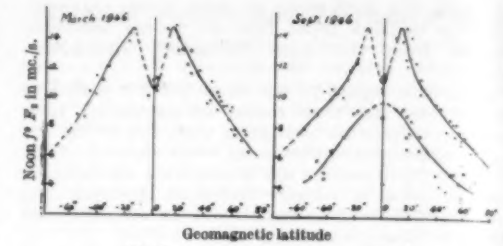


Fig. 1 Fig. 2

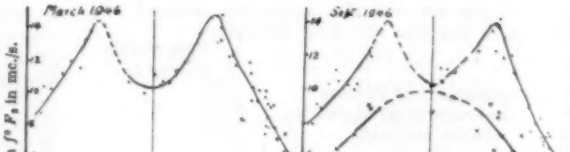


Fig. 3 Fig. 4

Our measurements for the zinc silicate sample examined led to a value $\alpha = 0{\cdot}036$. With the measured values of σ_0 and σ_T we calculated N_T/N_0 and compared it with the measured luminescence.

	$T°$ K.	300	418	518	623	648
$10^6\sigma_T$	obs.	0·022	0·35	2·2	8·3	10·7
N_T/N_0	calc.	0·996	0·94	0·72	0·40	0·34
	obs.	1·00	1·00	0·71	0·42	0·34

The same simple basic connexion was found to be valid for other phosphors too.

We express our thanks here to Prof. Z. Bay, director of the laboratory, for his interest, and to Prof. P. Gombás for suggestions and critical discussions.

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F_2 Ionization and Geomagnetic Latitudes

While studying the relation between the anomalous distribution of F_2 ionization in the ionosphere and the geomagnetic co-ordinates of various observatories, we found that Sir Edward Appleton had already published his results[1] (that issue of *Nature* was not available to us until two months ago owing to post-war difficulties), showing clearly the symmetry of F_2 critical frequencies with respect to the dip angles south and north of the magnetic equator. Later, Prof. S. K. Mitra gave reasons[2] explaining the geomagnetic control of F_2 ionization, and found that the location of maximum critical frequencies obtained from his calculation agrees very well with that shown by Appleton's result. In our work, the critical frequencies are plotted against the geomagnetic latitudes—Figs. 1 and 2 for March and September 1946. Compared with Figs. 3 and 4, where the critical frequencies are plotted against dip angles, they show a similar appearance of symmetry. I feel, however, that the dip angles as measured near the surface of the earth, inevitably influenced by local factors, may not represent at all well the geomagnetic effect in a region far above the earth such as the F_2 region in the ionosphere.

With reference to the above graphs, the following points are of interest:

(1) The two sets of curves for noon values of $f^0 F_2$, one for March and the other for September, are quite similar. Those plotted with geomagnetic latitudes as abscissæ both show maxima at approximately 14° N. and S.

(2) The curves plotted with dip angles[3] as abscissæ both have maxima around 38° N. and S. These seem to be different from Sir Edward Appleton's figure, in which maxima appear at 28° N. and S., as pointed out by Prof. Mitra in his communication.

(3) Midnight critical frequencies for September 1946 are also plotted in Figs. 2 and 4. There is no drop in value for stations near the magnetic equator. The distribution of points around the smoothed curves are much wider than for noon critical frequencies. However, they still show symmetry with respect to the geomagnetic constants (magnetic latitudes and dip angles) rather than geographic latitudes.

(4) It seems that the drop in ionization near the magnetic equator for the noon curves cannot be entirely attributed to the drift of ions caused by the earth's magnetic field. Since equatorial March or September corresponds to summer in temperate zones, the heating and expansion effect may also account for the drop in ion density. In the equatorial region, noon values are sometimes less than midnight values, as may be seen in the above graphs.

I wish to thank Messrs. S. Wang and W. Chow for their help in the preparation of this letter, and Dr. P. C. T. Kwei for his criticism. The world

ionospheric data which have been freely used in this work are supplied by the Central Radio Propagation Laboratory of the National Bureau of Standards, Washington, which subsidizes the Ionosphere Laboratory here in co-operation with the National Wuhan University.

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Wuchang, Hupeh, China.
August 14.

[1] Appleton, E. V., *Nature*, **157**, 691 (1946).
[2] Mitra, S. K., *Nature*, **158**, 668 (1946).
[3] Obtained from Fig. 8, p. 12, "Terrestrial Magnetism and Electricity", edited by J. A. Fleming.

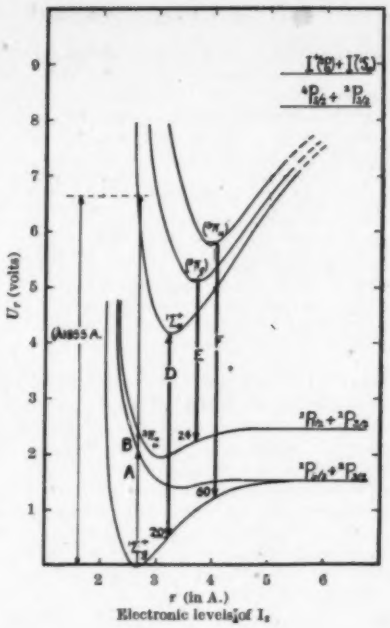
I agree with Prof. Liang about the desirability of plotting F_2-layer critical frequencies with magnetic latitude rather than with magnetic dip. In an article in *Science*, p. 17, July 4, 1947, I have given such a plot, which, for noon values of equinox critical frequency, shows two sharp maxima at ± 18° magnetic latitude. The high midnight values of F_2-layer critical frequency at stations on the geomagnetic equator are also attributed to the low electron recombination which is associated with the marked bifurcation of the F-layer into the F_1 and F_2 strata.

E. V. Appleton

Emission Spectrum of Iodine Molecules in the Presence of an Inert Gas

The emission spectrum of iodine (I_2) between 5000 and 2500 A. consists of a large number of diffuse bands (McLennan bands) and, especially in the presence of *small* amounts of an inert gas, of some apparently structureless continua[1] at 4800, 4300 and 3420 A. However, as has been shown, particularly by Elliott[2], the spectrum has quite a different appearance if excited in fluorescence by the Al spark lines at 1855–1863 A. in the presence of *large* amounts of nitrogen. The McLennan bands disappear almost entirely, the continua change into well-developed band systems at 4630–4440, 4321–4041(E) and 3450–3040 A.(D), and another well-developed band system appears at 2730–2520 A.(F). From a vibrational analysis of system D, Elliott was able to confirm an earlier interpretation of this system as an electronic transition from an upper state $^1\Sigma_u^+$ to the ground state $^1\Sigma_g^+$ of I_2 (with vibrational quantum numbers $v'' = 13$–29). He also set up a formula for system F, but his v''-assignment is uncertain, and indeed entirely incorrect according to our analysis. He was unable to interpret the other two systems.

We succeeded in obtaining the emission spectrum of iodine vapour in the presence of several hundred millimetres of argon by a high-frequency discharge. The spectrum was photographed with prism spectrographs of high dispersion and proved to be very similar to the fluorescence spectrum of Elliott. The main differences consist in the absence of the bands (degraded towards the violet) at 4630–4440 A., which, therefore, might belong to the molecule IN, and the appearance of three small continua or band systems at 2880, 2820 and 2770 A. not present in Elliott's fluorescence spectrum (but present in the spectrum excited by active nitrogen[3]). Our present investigation is concerned only with the well-developed band systems F and E. The vibration analysis of these systems strongly suggests the interpretation sketched



Electronic levels of I_2

in the accompanying figure. This assignment of electronic levels is supported by energy considerations based on the fact that the systems considered may be obtained in fluorescence by light of λ 1855 A.

The observed band heads, with very few exceptions, are represented, with an average error of about ± 2 cm.$^{-1}$, by the following formulæ :

System F : 2720–2533 A. bands degraded towards the red
$$\nu = 46440{\cdot}7 + (96{\cdot}21\,v' - 0{\cdot}49\,v'^2) - (213{\cdot}77\,v'' - 0{\cdot}599\,v''^2 - 0{\cdot}00367\,v''^3)$$
with $v' = 0$–5, $v'' = 40$–62, intensity maximum at $\sim v', v'' = 3{,}60$.

System E : 4327–4039 A. bands degraded towards the red
$$\nu = 25757{\cdot}2 + (101{\cdot}88\,v' - 0{\cdot}34\,v'^2) - (126{\cdot}59\,v'' - 0{\cdot}755\,v''^2 - 0{\cdot}0033\,v''^3)$$
with $v' = 0$–8, $v'' = 13$–32, intensity maximum at $\sim v', v'' = 1{,}24$.

Our formula for the ground-state of I_2 involved in system F is valid for high values of v'' only (say, $v'' > 30$) and converges, as expected, more strongly than the formula $\nu_{(v'')} = 213{\cdot}76\ v'' - 0{\cdot}596\ v''^2 - 0{\cdot}0021\ v''^3$ given by Loomis[3], following Mecke, for small values of v'' (0–20). The formula used for the lower state of system E is the one given by Loomis for the upper state $^3\Pi_g$ ($= O_u^+$) of the visible bands of I_2. The frequency difference of 5085 cm.$^{-1}$ between the upper electronic states of systems E and F suggests the tentative identification of these states with the terms $^3\Pi_g$ and $^3\Pi_u$ discussed by Mulliken[4].

All three band systems D, E and F are degraded toward the red and have their intensity maxima near the long wave-length end. This situation usually occurs if the atomic distance r' of the upper state is much larger than the distance r'' of the lower state, that is, if the upper potential curve has ionic character as discussed by Mulliken[4]. These states do not necessarily dissociate into the ions $I^+ + I^-$ but more probably into the lower lying state $I(^4P_{3/2}) + I(^2P_{3/2})$. It is of interest that ion-like spectra of this type occur also for the molecules HgX, CdX and ZnX[5], where X = Cl, Br, I.

A more detailed report is to appear in the *Helv. Phys. Acta*.

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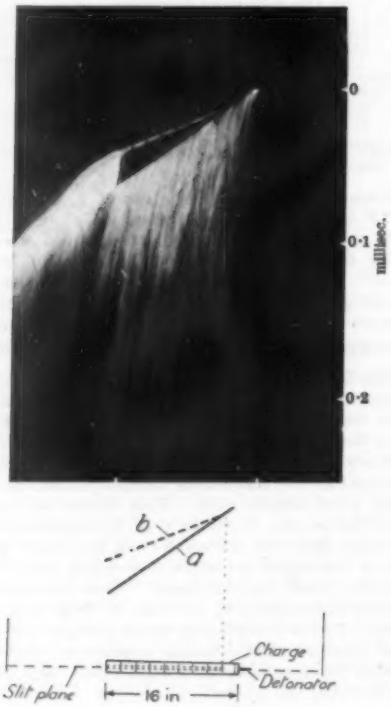
[1] A good survey is given by Curtis, W. E., and Evans, S. F., *Proc. Roy. Soc.*, A, **141**, 603 (1933). See also Venkateswarlu, P., *Proc. Ind. Acad. Sci.*, A, **24**, 480 (1946).
[2] Elliott, A., *Proc. Roy. Soc.*, A, **174**, 273 (1940).
[3] Loomis, F. W., *Phys. Rev.*, **29**, 112 (1927). Mecke, R., *Ann. Phys.*, 71, 104 (1923).
[4] Mulliken, R. S., *Phys. Rev.*, **46**, 549 (1934).
[5] Wieland, K., *Helv. Phys. Acta*, **14**, 420 (1941). See also Victor Henri Memorial Volume (Liège, in the press).

Velocity of Detonation of a Tubular Charge of Explosive

DETERMINATIONS of the velocity of detonation of unconfined columns of pressed tetryl pellets, made by me in these laboratories in 1941 by means of the Buxton rotating-mirror camera[1], showed that the velocity was higher by several hundreds of metres per second when there was a continuous cylindrical cavity in the column. For example, whereas the velocity of detonation in a cylinder of tetryl, 7/8 in. in diameter and of density 1·44, was 6,875 m./sec., the velocity in a cylinder of the same diameter but containing an axial cavity ¼ in. in diameter was 7,780 m./sec. Later experiments confirming and extending this result were made here by Dr. W. B. Cybulski with the same camera, after he had introduced modifications which considerably improved its accuracy.



The photographic record reproduced herewith was obtained by Cybulski with a tubular charge formed with pellets of an explosive, translucent when cast (40 : 60-tetryl/trinitrotoluene, density 1·62); the column was 16 in. long, 1¼ in. in diameter and contained an open cavity 14 in. long and 0·35 in. in diameter. Initiation was at the closed end. The trace depicted by line *a* of the explanatory diagram is formed by the detonation wave in the wall of the tube, and its slope corresponds with a speed of 7,380 m./sec. (the mean of six determinations having a range of 80 m./sec.). This is 255 m./sec. faster than the velocity of detonation, 7,125 m./sec., in a similar solid cylinder. With a narrower cavity, 0·25 in. in diameter, the speed in the wall rises to 7,410 m./sec., an increase over the normal rate of nearly 300 m./sec. The increase becomes smaller with wider cavities; for example, when the diameter is 0·64 in. the speed in the wall is 7,220 m./sec., an increase of only 95 m./sec. above the normal speed. The trace corresponding with line *b* of the diagram is of a luminous effect within the cavity and visible through the translucent explosive; it moves in advance of the detonation wave in the wall and is no doubt a manifestation of the well-known Munroe effect[2]. Within the cavity the speed is no less than 12,500 m./sec., and beyond the end of the column the effect is recorded as a flame of intense luminosity and long duration; for a short distance its speed is appreciably higher even than within the cavity.

Determinations of the velocity of detonation in cylinders of different diameters show that the value 7,125 m./sec. in this explosive is its limiting velocity, or the 'maximum possible velocity' of Berthelot. It is found that, when the cavity is filled with inert material such as 'Plasticine', the rate in the wall is the same as that in a solid charge; thus a higher value obtained experimentally with a hollow charge is abnormal in that it is a result of events within the cavity. That the passage of the luminous effect therein does not cause a forward motion of the tube, producing only an apparent increase in the velocity of detonation, has been proved by first superposing on the film a shadow photograph of the undetonated charge. At least two other explanations remain: that the passage of the internal effect is responsible either for immediate physico-chemical changes of the explosive in the wall, or for a modification in the form of the detonation wave therein.

The experimental work was carried out for the Ministry of Supply, and thanks are due to the Chief Scientist for permission to publish this note.

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June 21.

[1] Payman, Shepherd and Woodhead, Safety in Mines Research Board Paper, No. 99 (1937).
[2] Munroe, *Amer. J. Sci.*, **36**, 48 (1888).

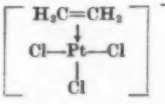
Co-ordination Complexes Containing Olefines

THE concept of the 'co-ordinate link' type of bond formed by donation of lone pair electrons has recently been generalized by Walsh[1] to include also donation by bonding electrons. A similar idea has been independently put forward by Dewar[2] to explain certain intramolecular rearrangements. This new idea that donation by bonding electrons may occur,

thus conferring donor properties on the olefinic linkage, is attractive from the purely chemical point of view. In addition to the examples already mentioned by Walsh, additional evidence in support of this concept is to be derived from a consideration of the ability of olefinic compounds to enter into complex formation with metallic salts. This ability has been known since Zeise[3] described the compound $K[PtCl_3.C_2H_4]H_2O$, and it has been found to be widely distributed among the metals, although most strongly exhibited by platinum (*vide* Anderson[4]), in which it has been shown that the ethylenic linkage is functioning as a specific co-ordinating group for platinum. Manchot and Brandt[5] have found that ethylene forms a co-ordinate complex with cuprous chloride analogous to that formed by carbon monoxide; furthermore, Manchot[6] has shown that blood absorbs ethylene, giving rise to a complex similar to, but more easily dissociable than, oxy- and carboxy-hæmoglobin.

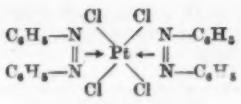
In all these co-ordination compounds with metallic salts there is evidence that ethylene plays a part analogous to that of carbon monoxide and ammonia in similar complexes; on chemical grounds there is no intrinsic difference between the co-ordination complexes containing ethylene and those containing either carbon monoxide or ammonia, and they differ merely in their relative degrees of stability. The complexes containing olefines are more easily dissociable, from which it may be inferred that the strength of the olefine → Pt bond is less than that of either the CO → Pt or the H_2N → Pt bonds. The exact nature of the bond uniting the olefinic molecule to the metallic atom has always remained rather obscure. As pointed out by Anderson (*loc. cit.*), the suggestion that a lone pair may be produced in the olefinic molecule by an electromeric change $R-CH=\overset{\curvearrowright}{C}H-R' \rightarrow R-\overset{+}{C}H-\overset{-}{C}H-R'$ (that is, derived from an excited state of the olefinic linkage) is unsatisfactory both on chemical and physical grounds.

Adopting Walsh's suggestion, however, the mechanism whereby the co-ordinate bond is formed may be readily understood; thus, for example, the structure of the anion of Zeise's salt can be satisfactorily represented by



On the basis of the above formulation of these olefinic co-ordination complexes, one might expect that the order of increasing co-ordination ability (as judged by the stability of the olefinic complexes) would run parallel with decrease in π^{-1} ionization potential. However, strict correlation between these two quantities may be counterbalanced by steric factors, which will also play an important part in determining the stability of the complexes. Thus Anderson (*loc. cit.*) has shown, for example, that *cis* configuration greatly promotes co-ordination.

Although in azoxy compounds lone pairs and not bonding electrons are donated, it is possible that in the co-ordination complex, which Kharasch and Ashford[7] have found to be formed between azobenzene and platinic chloride, bonding electrons are donated. The complex may be represented by



in which the azo → Pt bond is a π-electron dative bond, rather than a normal 'co-ordinate link' type of bond formed by the lone pairs on the individual nitrogen atoms.

In view of the general reactivity of the π-electrons in olefinic compounds, as exemplified in the electromeric change , and in donor properties, I would suggest that the conventional double bond formulation might with advantage be rewritten as . Such a formulation would attempt to distinguish between those electrons in the hybridized sp^2, σ bonds and the electrons in a pure $2p_z$ orbital which are responsible for the characteristic reactivity of olefinic compounds.

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[1] Walsh, *J. Chem. Soc.*, 89 (1947).
[2] Dewar, *J. Chem. Soc.*, 406, 777 (1947).
[3] Zeise, *Pogg. Ann.*, **21**, 497 (1831).
[4] Anderson, *J. Chem. Soc.*, 971 (1934); 1042 (1936).
[5] Manchot and Brandt, *Ann.*, **370**, 286 (1911).
[6] Manchot, *Ann.*, **370**, 241 (1911).
[7] Kharasch and Ashford, *J. Amer. Chem. Soc.*, **58**, 1733 (1936).

Influence of the Sugar Concentration on the Growth of Isolated Pine Roots

Some preliminary observations are submitted below concerning the culture of isolated roots of a coniferous tree species, *Pinus sylvestris*.

Seeds were collected in the province of Vermland, Sweden (Uddheden, Grasmark, 110 m. above sea-level). To obtain as uniform a rate of germination as possible[1] only the darkest seeds, which were the most numerous, were selected for the experiments. The seeds were disinfected by a 15-min. treatment with a solution of calcium hypochlorite according to Wilson's[2] and Melin's[3] techniques, and were then carefully washed in sterile distilled water. Germination took place at 20° C. on 1·5 per cent washed agar contained in Petri dishes. Root tips approximately 10 mm. long were removed from the seedling roots and transferred to 100 ml. Erlenmeyer flasks (Jena glass) containing 20 ml. of nutrient medium. This medium contained per litre of redistilled water (specific conductance at 18° C. = $1·09 \times 10^{-6}$ reciprocal ohms) the following mineral salts[4]: 50 mgm. $Ca(NO_3)_2$, 10 mgm. $MgSO_4$, 10 mgm. KH_2PO_4, 1 mgm. $FeCl_3$, 0·1 mgm. $Na_2B_4O_7$, 0·1 mgm. $MnCl_2$, and 0·1 mgm. $ZnCl_2$.

As source of carbon and energy use was made of (1) glucose (Pfanstiehl, "C.P. Grade") and (2) sucrose (Schering–Kahlbaum, *puriss.*). The media were supplemented with thiamin (1 γ per 20 ml.), and with biotin (0·001 γ per 20 ml.). The vitamin preparations used were thiamin hydrochloride Merck (Darmstadt) and biotin Merck (Rahway, N.J.).

The culture flasks containing the nutrient solutions were sterilized by autoclaving for 15 min. at a pressure

of 1 kgm. per cm.², corresponding to a temperature of 120° C. The inoculated flasks were incubated at 20° C. for 60 days.

TABLE 1. INFLUENCE OF GLUCOSE CONCENTRATION ON THE GROWTH OF ISOLATED PINE ROOTS

Glucose, per cent	Average total length of 14 roots in mm.	Average number of branches
2	7·8	2·5
3	26·3	3·6
4	46·1	4·2
5	21·6	3·1
6	9·8	2·0

TABLE 2. INFLUENCE OF SUCROSE CONCENTRATION ON THE GROWTH OF ISOLATED PINE ROOTS

Sucrose, per cent	Average total length of 14 roots in mm.	Average number of branches
3·9	14·7	2·5
5·8	79·4	7·4
7·7	28·3	2·9
9·6	6·6	2·3
11·6	0·0	0·0

Some results obtained in assaying the influence of different sugar concentrations on the growth are listed in Tables 1 and 2. In these experiments the nutrient solutions contained 2–6 per cent glucose or of sucrose in a corresponding molarity (3·9–11·6 per cent). The optimum glucose concentration was found to be 4 per cent, while the optimum sucrose concentration was 5·8 per cent, in molarity equivalent to 3 per cent glucose.

Sucrose gave rise to considerably more powerful growth and more branches than glucose, and may hence be a more suitable source of carbon for isolated pine roots than the latter.

The investigation is being continued.

V. SLANKIS

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July 3.

[1] Kujala, V., *Comm. Inst. Quaest. Forest. Finland.*, **12** (1927).
[2] Wilson, J., *Amer. J. Bot.*, **2**, 420 (1915).
[3] Melin, E., "Abderhalden: Handb. biol. Arbeitsmethoden", Abt. XI, Teil 4, 1,015 (1922).
[4] Robbins, W. J., and White, V. B., *Bot. Gaz.*, **98**, 209 (1936).

Mendelian Inheritance in New Zealand Romney Sheep

THE present purpose is to report further changes in our views on the genetics of *N*-type sheep. As stated and illustrated previously[1,2,3], these animals have very high abundance of halo-hairs in the birth-coat, and their fleeces are usually hairy, that is, have much medullation. Of our four *N*-type stocks, one has been called 'multifactorial-*N*', two are 'dominant-*N*' and one 'recessive-*N*'.

The so-called multifactorial-*N* stock is related to both dominant-*N* stocks, Nielsen-*N* and Massey-*N*. Evidence from experiments not quite complete points to the *N*-gene being the same in both dominant stocks. Breeding tests still in progress make it probable that the 'multifactorial' stock is multifactorial only for modifiers aiding the expression of the dominant-*N* gene. The foundation animals, among the descendants of which selection for *N*-type proved rapidly successful, all had many halo-hairs, but fewer than *N*-type. The original ram, which was horned, and to which the whole stock is traceable, and several of the earliest ewes, were so bred that they could be heterozygous for the dominant-*N* gene. By this time we are familiar with the fact that the dominant-*N* gene may come to poor or even very poor expression in heterozygotes. Finding ourselves thus without any stock that can be regarded as multifactorial in the sense that no one gene plays a major part, we are the more anxious that the genetics of the coats of the hairy mountain sheep of the northern hemisphere should be studied.

Our central problem is the relation between dominant-*N* and recessive-*N*. For four years the hypothesis under test has been that dominant-*N* was a duplication of recessive-*N*. The two genes would then be allelomorphic. *N*-type sheep have been secured from the mating of recessive-*N* and dominant-*N*. Two such recessive-dominant *N*-type rams have been mated with recessive-*N* ewes. The lambs are 20 *N*-type; 7 non-*N*. Four of the non-*N* lambs are by one ram, three by the other. This is the 3 : 1 ratio expected if the genes are independent. The hypothesis is therefore no longer tenable. We are the more anxious to announce this result because reference has been made to this hypothesis by Prof. Ruggles Gates[4,5]. Sheep-breeding experiments take a long time, and it is therefore our policy to pass ideas to fellow-workers in a manner which would be thinking aloud too much if mice were our material.

Recently, we enjoyed the privilege of discussing this work with Prof. Richard Goldschmidt during his visit to New Zealand. He pointed out how often the same character in *Drosophila* is conditioned by different genes, and told us that the simplest interpretation is complete independence of the dominant-*N* and recessive-*N* genes. There is, however, evidence from breeding results, the critical discussion of which would take too much space, which allows us still to wonder whether the two genes, though resident on different chromosomes, may indeed be the same. It is suggestive, too, that in both dominant-*N* and recessive-*N* sheep the same pleiotropic effects occur. The problem is being tackled by further breeding, and one of us (A. S. F.), whose earlier research has been in plant cytogenetics, is studying the chromosomes of rams of different genotypes.

The fact that the two genes are carried by different chromosomes gives greater scope for the study of dosage effects. Horns in ewes, for example, are the rule in homozygous dominants; small horns are frequent in recessive-dominant ewes; horns occur occasionally in heterozygous dominants; and they have not yet been recorded in recessive-*N* ewes. Other characters are being studied in the series of genotypes, notably the abundance of the several fibre types of the birth-coat.

Our attention has recently been directed to the possible application of this fundamental work. In the early days of this College, research was started on hairiness because it was regarded as a wool fault. Then the emphasis came to be put on the genetics of *N*-type. Early in 1946, Prof. A. F. Barker visited New Zealand and spent several days at this College. He urged the breeding of *N*-type sheep on a larger scale in order to supply one of the world's best carpet wools.

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June 9.

[1] *Nature*, **145**, 390 (1940).
[2] *Nature*, **148**, 563 (1941).
[3] *Nature*, **154**, 552 (1944).
[4] *Amer. Nat.*, **80**, 76 (1946).
[5] "Human Genetics", 17 (New York, 1946).

'Foveal Tritanopia'

In his book on colour vision, Dr. W. D. Wright[1] discusses blue-blindness of the retinal fovea, which was described by A. Koenig[2] fifty years ago and is now maintained by Willmer[3] and himself for the same reasons: "This effect does not appear to have been the subject of further extensive study and although other workers were aware of Koenig's observation the general attitude appears to have been one of scepticism. Indeed most people either ignored or were ignorant of the phenomenon until Willmer recently reawakened interest in the subject." Dr. Wright has apparently overlooked the controversy between E. Hering and A. Koenig.

Koenig's[2] hypothesis that the visual purple and yellow are the photochemical substances for grey and blue sensations, the rods the colour-receptors, and the cones only dioptric means to throw the retinal images on the rods, led him to the assumption that the purple-free fovea were blue-blind. His observations with colour equations seemed to confirm his assumptions, as in the case of Drs. Willmer and Wright.

Hering[4] attacked Koenig's observations and conclusions in a paper noteworthy for its concise reasoning and the sharpness of its criticism. Hering showed that direct foveal observation of small blue test objects demonstrates the perfect blue-sensation of the fovea, provided that some precautionary measures are taken which he prescribed with exactness, and that the fovea is the most colour-sensitive spot of the retina.

Conclusions from colour equations and colour-matches on such small retinal fields as the fovea led Koenig to the error of foveal blue-blindness. Colour equations are only valid under three conditions: that the test is of sufficient brightness, that the retinal field has a minimum size, and that the eye is not tired. Hering had shown already in an older paper[5], before Koenig's publication, that the validity of colour equations is limited and that the latter are not valid on very large fields or very small retinal fields such as the fovea. Colour equations with blue-green mixtures need much more blue on small retinal fields such as the fovea (1893). Koenig's short reply[6] was not convincing at all; a more detailed one was promised but never published—a later paper of pathological blue-blindness due to ablatio retinæ and retinitis has nothing to do with the problem in question. Hering[7] replied and again refuted concisely foveal blue-blindness and Koenig's strange theory of the function of rods and cones, just at the time of the making of the duplicity theory. Everyone of that time interested in the subject knew of Koenig's publication and his lecture at the Academy of Sciences in Berlin, and also of the controversy with Hering. There is little doubt that authorities of those days such as v. Kries, Lord Rayleigh and Nagel put such an important question to the test, as was easily done from Hering's description.

Many years after Koenig's death, Sir John Parsons[8] rejected strongly foveal tritanopia in his standard work on colour vision, saying, "This observation (i.e., Koenig's) is certainly untrue". Curiously, he did not cite Hering on this question, although he quotes him otherwise more than sixty times in his excellent book.

Recently, Prof. H. Hartridge[9] has rejected foveal tritanopia for precisely the same reasons as E. Hering in the old days, showing in detail that colour equations are not valid on retinal fields so small as the fovea, and direct foveal observation of blue tests gives clear blue response. But there is again no reference to the work of Hering or Helmholtz[10]; the latter was aware of these facts even before Hering. These facts are not at all recent advances, but apparently they have been forgotten nowadays.

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1 Wright, W. D., "Researches on Normal and Defective Colour-Vision" (1946).
2 Koenig, A., "Ges. Wissenschaftl. Abhdlg.", 338 (1903).
3 Willmer, E. N., *Nature*, **153**, 774 (1944). Willmer, E. N., and Wright, W. D., *Nature*, **156**, 119 (1945).
4 Hering, E., *Pflueger's Archiv.*, **59**, 403 (1895).
5 Hering, E., *Pflueger's Archiv.*, **54** (1893).
6 Koenig, A., *Pflueger's Archiv.*, **60** (1895); "Ges. Wissenschaftl. Abhdlg.", chapter 25 (1903).
7 Hering, E., *Pflueger's Archiv.*, **61** (1895).
8 Parsons, J. H., "Introduction to Colour Vision", 81 (1915 and 1924).
9 Hartridge, H., *Nature*, **155**, 391 and 657 (1945).
10 Helmholtz, "Physiol. Optik" (2nd edit., 1896), 374.

All workers on colour vision will, I am sure, welcome Dr. Karplus' letter, especially for the historical notes on the dispute between Koenig and Hering. It is quite evident from this that the dichromatism of the central fovea, when reported by Koenig fifty years ago, was the subject of some heated discussion; at the same time, when Willmer[1] re-discovered the effect in 1944, it is probably true to say that most workers in the subject had either ignored or were ignorant of both Koenig's results and Hering's discussion of them, and I would have to admit to being among that number. No doubt there were exceptions, and Dr. Karplus is certainly one honourable example; but then I understand that he had the great privilege of working under Koenig in his laboratory—a privilege that may well be unique among those alive to-day.

With regard to the phenomenon itself, I think it should be made clear that the recent observations by Willmer[2], Thomson[3] and myself completely substantiate Koenig's original colour-matching experiments. I suspect that many of the difficulties and differences of opinion that have arisen in explaining the dichromatism have had their origin in the different connotations applied to the word 'dichromatism' and also to the misuse of the word 'blind'. As generally understood at the present time, dichromatism implies that colour matching can be carried out by the mixture of only two matching stimuli, and it is in this sense that the central fovea has been described as dichromatic, and not in the sense of there being only two qualities of sensation associated with its stimulation. The misuse of the word 'blind' is quite extensive in the frequent description of persons with defective colour vision as being 'colour-blind', although the great majority are in no sense blind to any of the radiations in the visible spectrum, since their essential defect is a reduced ability to discriminate the colour quality of one wave-length from that of another. In the same way, it is incorrect to refer to tritanopia as 'blue-blindness'. The radiations at the short-wave end of the spectrum may be perfectly visible and may even give rise to the sensation of blueness, yet at the same time a tritanope or a tritanopic area of the retina will have a reduced ability to discriminate colours in the blue-green region of the spectrum. It is true that observations by Thomson and myself[3], and other measurements reported by Dr. W. S. Stiles at Cambridge last July

during the International Colour Vision Conference, show that some loss of blue sensitivity may occur in the central fovea, but we have not suggested that the fovea is blind to these radiations.

Koenig's interpretation of the dichromatism was no doubt in error. It is, however, important not to condemn the experiments along with the theory, and I have no doubt at all about the fundamental soundness of Koenig's original observation of foveal tritanopia, nor of Willmer's re-discovery of the phenomenon.

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[1] Willmer, E. N., *Nature*, **153**, 774 (1944).
[2] Willmer, E. N., and Wright, W. D., *Nature*, **156**, 119 (1945).
[3] Thomson, L. C., and Wright, W. D., *J. Physiol.*, **105**, 316 (1947).

Visual Cells of the Guinea Pig

THE statement of Granit[1] that the guinea pig has a "pure rod eye" calls for comment. Franz[2], referring to a paper of his own published in 1909, says that cones are missing from the retina of the guinea pig. Ovio[3] admits the presence of a few cones. Kolmer[4] describes cones and rods. He makes the significant remark that observation prior to his own had been made on poorly fixed material. Rods are four to five times as numerous as cones, and he comments on the clear vacuoles at the peripheral end of the cone myoids.

Preparations of my own made nearly ten years ago confirm the findings of Kolmer. Neither the cornea nor the lens is as large as one would expect in an eye populated only by rods. The ratio of nuclei in the outer layer to that of the bipolars is four, or at the most five, to three (excluding the nuclei of Müller's fibres), a much lower ratio than one expects in a pure rod retina. In the dog it is twelve to four at least, and in a jerboa mouse (*Notomys cervinus* Gould) sixteen to five. These ratios are only approximate, but are an indication of the amount of summation of impulses in the retinæ of these two eyes rich in rods. The eye of the dog is larger than that of the guinea pig, that of the Jerboa mouse smaller. Cup-shaped vesicular areas in the outer molecular layer of the guinea pig's retina suggest that some of the visual cells have dendritic foot-pieces. In my own preparations the cone myoids project beyond those of the rods. The tip of the distal segment of the cone is enveloped in a process of the pigment epithelium, and in areas where the visual cells have lost touch with the pigment epithelium, the cones do not part company with it as easily as do the rods. This enveloping of the tip of the cone has been commented on in the human retina by Walls[5] and Kolmer[6].

To the histologist, the retina of the guinea pig is certainly not 'pure rod'.

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St. Vincent's Hospital,
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July 8.

[1] Granit, R., *J. Physiol.*, **103**, 103 (1944).
[2] Franz, V., "Vergleichende Anatomie des Wirbeltierauges", in "Handbuch der Vergleichende Anatomie der Wirbeltiere", **2**, pt. 2, 1,238. (Vienna: Bolk/Goppert/Kallius/Lubosch, 1934.)
[3] Ovio, J., "Anatomie et physiologie de l'œil dans la série animale", 139 (Paris, 1927).
[4] Kolmer, W., "Vergleichende Anatomie der Netzhaut", in "Handbuch der Mikroskopischen Anatomie des Menschen", **3**, pt. 2, 321–326 (Fig. 259), 420–21 (Berlin, 1936).
[5] Walls, G. L., *Arch. Ophthal.*, **12**, 1918 (1934).
[6] Kolmer, W., *ibid.*, 318 (Fig. 251 *A*).

Sound Emitted by Dolphins

DURING a cruise in the Mediterranean last year on board the Swedish research ship the *Skagerak*, I happened to notice that the dolphins (*Delphinus delphis*) uttered sounds that were quite audible on board the ship, though the dolphins were swimming one or two metres below the surface. The sounds may be described as short, rapidly repeated squeaks rather like those produced by fighting or playing mice. As I had many opportunities of listening to the sounds, sometimes with the ship at rest in calm weather, and had several other persons verify the observation, there can be no doubt as to the ability of the dolphins to produce audible sounds.

B. KULLENBERG
Oceanographic Institute, Gothenburg.

Elemental Nomenclature

IT may be presumptuous for a zoologist to speak to a chemical question. However, the points raised by Vallarta and Arnaiz y Freg and by Webb in *Nature* of August 12, pp. 163–64, are on all fours with problems of nomenclature familiar to biologists. Del Rio's erythronium was validly published and, from a zoological point of view, his subsequent disavowal was an ineffective act. The chemists are well advised in being cautious about the unreasoning application of the rule of priority. Since the number of elements seems unlikely to be much in excess of a hundred, the problem is quite simple compared with the handling of some 200,000 generic names of animals. Hence the homonymy between two uses of plutonium causes no confusion. Perhaps a new rule might read that if a name has had no employment for fifty years, whether or not withdrawn by its author, it shall become a *nomen vacuum*, with the recommendation that such names should not be re-used with a new meaning. Finally, this rule or any other nomenclatorial rule should not be applied retroactively, since there is an implied contract between the rules and the public that a change in the rules shall not render a previously legal usage illegal. The lawyer calls this *stare decisis*.

CHARLES H. BLAKE
Department of Biology,
Massachusetts Institute of Technology,
Cambridge, Massachusetts. Sept. 2.

"Miracles"

IN my recent review of Mr. C. S. Lewis' book on "Miracles", I wrote that what are described as miracles "occur most freely in periods when critical skill is least". From Mr. E. V. Burke, writing from 27 The Crescent, London, S.W.13, I have received references to the following books on cures recorded at Lourdes: E. le Bac, "Medical Proof of the Miraculous, a Clinical Study" (1922), and G. Bertrin, "Lourdes, its Apparitions and Cures" (English translation by Lady Gibbs), and the *Catholic Medical Guardian*, 1933–34 (case of Pierre de Rudder, broken leg cured instantaneously), which may not be generally known.

I have only to add that I did not say that such cures do not occur when (or where) critical skill is adequate; and Mr. Burke himself writes that "many claimants to miracles are completely rejected" at Lourdes.

JOHN L. MYRES
Oxford.

PUBLICATION AND CLASSIFICATION OF SCIENTIFIC KNOWLEDGE

THE direct importance to the research worker of an efficient scientific information service led the Cambridge Branch of the Association of Scientific Workers to hold a conference on October 25 to discuss various schemes that have been proposed. Although the subject had been discussed previously by professional abstractors and librarians, this was the first conference of 'users' of scientific information.

The chairman, Sir Lawrence Bragg, outlined the two main aspects of the problem: (*a*) how are scientific workers to get to know of the work that interests them, and (*b*) having learned of it, how can they get a copy of the actual publication. The first is by far the more difficult. As regards the second, the personal contact provided by correspondence is invaluable, and any centralizing scheme must avoid destroying this.

	Books > 50,000 words	Pamphlets 10,000–500,000 words	Papers 5,000–100,000 words	Letters or Notes 100–5,000 words	Abstracts or Titles < 100 words
Ephemeral		Research programmes §	Lectures	Letter on work in progress	Title of research project
Operative		Theses † (full experimental detail and mathematical argument)	The scientific paper *†	Note or informative abstract *†	Indicative abstract *
Collective		Monographs	Report *§ (e.g., annual) on progress of a subject	Book reviews and critical articles	Bibliographies §
Definite	Treatises		Handbooks §	Data tables § (fauna – flora, maps, etc.)	General indexes §
Utilitarian	Text-books. Popular science books	Practical monographs	Technical articles	Technical notes	

Note.—The four essential units are outlined with heavier rules.

* To be received automatically. † To be received on request through agency. § Central responsibility for preparation.

Prof. J. D. Bernal divided scientific information into 'operative units' according to their length and function (see table). Thus the scientific 'paper' is the operative unit, not the journal. Abstracts should be of two kinds, 'indicative' and 'informative'. The former merely guides you to the paper while the latter should be full enough to be adequate for 'background' reading. By the term 'thesis', he means the fullest possible account of a piece of research, not necessarily a dissertation for a doctorate. He proposed a single subscription to a national distributing agency which would entitle one to receive automatically, say, 1,000 papers a year plus abstracts of a given field or fields. Further papers or theses could be obtained on request.

Those present at the conference agreed generally with this scheme, provided that the scientific journals continued also to be available in bound series in libraries. Prof. R. S. Hutton pointed out the present and future financial difficulties of the societies in publishing their journals, and suggested that a proper financial arrangement with such a national distributing agency might be decisive in obtaining their agreement to the scheme. Mr. J. W. S. Pringle emphasized that editorial responsibility must rest with the societies, and that it is really a question of the suggested agency buying the copyright and a large number of reprints. Dr. E. Orowan and Prof. Hutton quoted a number of societies, mainly in the metallurgical and engineering fields, which are, in fact, partially operating the proposed scheme, as they treat the paper as the unit and later assemble them into *Transactions*.

Whether reprinting is the most economical method of reproduction was doubted by Mrs. Lucia Moholy, and she gave figures to support the use of microfilming, particularly when the demand could not be forecast. Dr. D. P. Riley praised the microfilm service run in conjunction with abstracts published by the Centre National de la Recherche Scientifique in Paris, and said that the French Thomson-Houston microfilm-viewer is very good. In discussion, the need for an efficient and cheap British microfilm-viewer (costing about £30) was underlined.

The different needs of the biological and physical sciences were referred to by several speakers. The abstracting service of the Imperial Bureau of Plant Breeding and Genetics was described by Mr. R. H. Richens, while Prof. H. Jeffreys dealt with the position in astronomy, meteorology and geophysics. It was agreed that abstracting should always be done in one of the common European languages. Some interesting suggestions were made with reference to the classification and indexing of scientific papers, and the need for a fundamental theory of classification was made obvious. Most speakers favoured, as an immediate measure, the extension of the Universal Decimal Classification to meet the requirements of new branches of science such as nuclear physics. Mr. J. B. Hasted suggested that the cross-referencing difficulty might be overcome by using a matrix system. Dr. S. Lilley objected to the use of the decimal system, as classification on a binary scale is much more efficient and flexible. The logic of classification is better on a dual system and is ideal for use with machines. His own simple knitting-needle and punched-card system gives the possibility of 10^{33} classes on one card.

An editor's opinion was given by Dr. R. C. Evans. He compared American and British practice; he is convinced that many of the reasons for delays in publication lie in the form in which papers are submitted. The increased speed of communications should logically lead to the creation of international

journals such as the old *Zeitschrift für Kristallographie* and the new *Acta Crystallographica*.

Some indication of the need for rationalization was provided by figures given by Prof. Hutton. The number of worthwhile scientific periodicals is 15,000, and the number of original papers in these journals is about 750,000 per year. Of these, 1 in 3 are abstracted; but it should be noted that chemistry accounts for a great number as it is the most thoroughly abstracted branch of science.

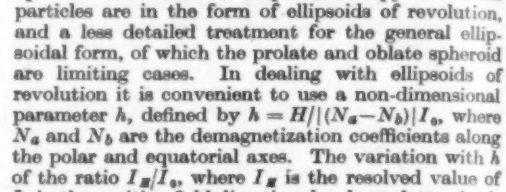
INTERPRETATION OF HIGH COERCIVITY IN FERROMAGNETIC MATERIALS

By Prof. E. C. STONER, F.R.S.,
AND
E. P. WOHLFARTH
Physics Department, University of Leeds

IN the generally accepted theory of the ordinary magnetization curves of ferromagnetics, due to Becker, Kersten and many others, and fully described by Becker and Döring[1], coercivity is related to the amplitude of internal stress variations through their effect on domain boundary movement. Although there can be little doubt as to the correctness of the basic ideas, or to their wide applicability, the treatment cannot account for coercivities of 500 oersted, and more, which are obtained in modern permanent magnet materials, without arbitrary and improbable assumptions about the magnitude and character of the internal stress variations. It occurred to one of us some years ago that for those alloys of the dispersion-hardening type for which the higher coercivities are found, an entirely different type of explanation might be possible, and some preliminary calculations gave promising results. This line of inquiry was interrupted by the War, and no more than vague references to it have been published[2], though it has been discussed verbally and in correspondence with others interested. A systematic attack on the problem was resumed at the beginning of 1946, and a full account of the work has now been prepared. In view of the inevitable delays in publication a brief account may be appropriate here. It may be stated quite frankly that the immediate stimulus to this communication has been two short and admirable papers by Néel[3], which have just appeared, and which show that he has been thinking along similar lines with particular reference to powder magnets.

The central idea is that in many ferromagnetic materials there may occur 'particles' (this term including both actual powder grains and atomic segregates or 'islands' in alloys), distinct in magnetic character from the general matrix, and less than the critical size, depending on shape, for which domain boundary formation is energetically possible. For particles in the form of ellipsoids of revolution, a reasonably precise expression for the lower limit to this critical size is obtained, involving the saturation intensity, I_s, and the Curie temperature of the material of the particle and the smaller demagnetization factor. For spherical particles, the lower limit to the critical diameter is found to be $0{\cdot}8 \times 10^{-6}$ for iron, and $3{\cdot}1 \times 10^{-6}$ for nickel, the number of atoms in the volume being about $1{\cdot}5 \times 10^{5}$ and $1{\cdot}2 \times 10^{7}$ respectively. For prolate spheroids of dimensional ratio 10, the diameters are some four times as great, and the number of atoms $1{\cdot}1 \times 10^{9}$ and $8{\cdot}1 \times 10^{10}$. In such single-domain particles, change of magnetization can take place only by rotation of the magnetization vector, I_s, which remains constant in magnitude and uni-directional throughout the particle. As the field changes continuously, the resolved magnetization in the field direction may change discontinuously at critical values of the field. The character of the magnetization curve depends on the degree of magnetic anisotropy of the particle, and on the orientation of the 'easy axes' with respect to the field. The magnetic anisotropy may be due to anisotropy of shape (the energy depending on direction owing to the directional dependence of the demagnetizing field), magneto-crystalline anisotropy or strain anisotropy.

A detailed quantitative treatment has been developed of the effect of shape anisotropy when the particles are in the form of ellipsoids of revolution, and a less detailed treatment for the general ellipsoidal form, of which the prolate and oblate spheroid are limiting cases. In dealing with ellipsoids of revolution it is convenient to use a non-dimensional parameter h, defined by $h = H/|(N_a - N_b)|I_s$, where N_a and N_b are the demagnetization coefficients along the polar and equatorial axes. The variation with h of the ratio I_H/I_s, where I_H is the resolved value of I_s in the positive field direction, has been determined, by accurate numerical solution of the equilibrium equations, for a series of angles, θ, ranging from 0° to 90°, of the orientation of the polar axis with respect to the field, and also for random orientation. The magnetization curves for random orientation are shown in the accompanying figure, where the full curves refer to prolate spheroids, the broken curves to oblate spheroids.



For the special limiting case of the oblate spheroid, there is no hysteresis (this applies to all orientations), though there is a discontinuous change in the magnetization as the field passes through zero. For the prolate spheroid, exact expressions are obtained for the critical field, h_0, at which the discontinuous change occurs, and for various related quantities, as functions of the orientation angle, θ. As θ varies from 0° to 90°, the cyclic magnetization curves change from a rectangular form, with $|h_0| = 1$, to a linear non-hysteretic form, with an interesting sequence of intermediate forms. The lowest value of $|h_0|$ is $\frac{1}{2}$, occurring for $\theta = 45°$.

All the numerical results are applicable when the anisotropy is due to longitudinal stress, when h and H

are related by $h = HI_s/3\lambda\sigma$, where λ is the saturation magnetostriction coefficient, and σ is the stress. If λ and σ are of the same sign (as for nickel under compression and approximately for iron under tension) the behaviour is similar to that of prolate spheroids; when the signs are opposite, to that of oblate spheroids. The results also apply to magnetocrystalline anisotropy in the important and representative case in which there is a unique easy axis of magnetization, as for hexagonal cobalt; in this case, h and H are related by $h = HI_s/2K$, where K is the magnetocrystalline anisotropy coefficient.

In general, all three types of anisotropy may be present, and an estimate of the relative magnitudes of the effects is important. For magneto-strain anisotropy, assuming as a reasonable upper limit of the stress, σ, a value of 200 kgm.mm.$^{-2}$, the maximum values of H/h for iron, nickel and cobalt are about 600, 4,000, and 600 respectively. For the magnetocrystalline effect, H/h is about 6,000 for cobalt; for cubic crystals, the numerical results obtained do not apply in detail, but the maximum coercivity may readily be estimated as about 400 for iron, and 200 for nickel. For shape anisotropy, H/h has a maximum value (for elongated particles) of $2\pi I_s$, giving about 10,800 for iron, 3,200 for nickel and 8,900 for cobalt; even for a dimensional ratio as low as 1·1, the values are 810, 240 and 670 respectively.

Although the mechanism outlined, involving magnetically anisotropic single-domain particles, may be involved to some extent in a wide range of ferromagnetic materials, there are three types of materials in which it is likely to be of predominant importance. These are (1) powder magnets, (2) non-ferromagnetic metals and alloys containing ferromagnetic 'impurities'[4], and (3) high coercivity alloys[5] of the dispersion-hardening type. Néel's papers are concerned particularly with powder magnets, which have been greatly developed in France in recent years, and about which little information was accessible to us. A survey of the literature on (2) and (3) leaves little doubt that the 'single-domain particle' mechanism provides in many cases a more satisfactory interpretation of the observed magnetic characteristics than any other that has so far been suggested. As the coercivities are often in the region of 500, it is usually not possible from the evidence available to draw definite conclusions as to the type of magnetic anisotropy primarily involved, though with coercivities appreciably greater than this, and with 'iron-like' segregates, there is strong presumptive evidence of some degree of shape anisotropy. For alloys of the alcomax or ticonal type, for which the remarkable effect of cooling in a magnetic field is well known, but not satisfactorily explained, it is significant that the demagnetization curves along and perpendicular to the direction of this field are strikingly similar to those for single-domain particles with a unique easy axis of magnetization aligned at nearly 0° and nearly 90° to the applied field. This suggests that cooling in a field favours a preferential growth of single-domain segregates with easy axis along or near the field direction.

[1] Becker, R., and Döring, W., "Ferromagnetismus" (Springer, Berlin, 1939). (Photo-lithoprint reproduction, Edwards Bros., Ann Arbor, Michigan, 1943.) See also Kersten, M., *Phys. Z.*, **44**, 63 (1943).

[2] Stoner, E. C., *Proc. Phys. Soc.*, **52**, 175 (1940); *J. Inst. Elec. Eng.*, **91**, 340 (1944); *Phil. Mag.*, **36**, 803 (1945).

[3] Néel, L., *C.R. Acad. Sci. Paris*, **224**, 1488 and 1550 (1947).

[4] For a review, see Constant, F. W., *Rev. Mod. Phys.*, **17**, 81 (1945).

[5] For a review, see Hoselitz, K., *J. Sci. Instr.*, **23**, 65 (1946).

THE MELLON INSTITUTE

ANNUAL REPORT FOR 1946–47

REVIEWING the post-war plans of the Mellon Institute of Industrial Research in the thirty-fourth annual report, the director, Dr. E. R. Weidlein, refers to the loss by the Institute since 1942 of many able scientific workers and to the difficulty, in view of the general shortage of scientific man-power, of acquiring the staff required for expansion. It is a part of the Institute's responsibility to foster the training of research workers, however, and of 609 'fellows' who left the Institute during 1913–46, forty per cent took up appointments with the donors of their fellowships and 6·7 per cent with other donors. The average term of service of these fellows was four and a half years, as compared with an average of 7·2 years for fellows now in the Institute. During 1946–47, the Institute had 295 fellows in applied science with a further nine in the department of research in pure chemistry and five in that of research in chemical physics, together with a total of 283 associates, assistants and laboratory technicians. Eighty industrial fellowships were in operation during the year, of which fifty were multiple fellowships. Six fellowships had been proceeding for thirty years or more, two for at least twenty-five years, nine for fifteen years and nineteen for at least ten years.

The Department of Research in Pure Chemistry continued to focus attention on synthetic organic chemistry as applied to biological and chemotherapeutic problems, and in a study of the nitrophenyllepidylcarbinols, good yields of the *m*- and *p*-nitrobenzylidenedilepidine compounds have been obtained. A series of substituted 4-amino-6-β-hydroxyethoxyquinolines was prepared, as well as some quinoline azomethines and their hydrogenation products. The comparative properties of 2- and 4-mercapto-7-methylquinoline have been investigated, and the study of specialized uses of hydroxyethyl apocupreine and related derivatives in chemotherapy has been resumed and extended. Research has been advanced on the reactivity of esters of *p*-toluene sulphonic acid towards sodium iodide dissolved in acetone. Investigation of the kinetics of the reaction of substituted ethyl benzene sulphonates with sodium ethoxide in ethyl alcohol indicates that the reaction is of the second order, and some attention has been given to the synthesis of the substituted benzene sulphonyl chlorides. Use of cyclic alkylene carbonates and sulphites for hydroxyalkylation of phenols, amines and mercaptans has been extended to esters of 1 : 2- and 1 : 3-glycols. The chemistry of pyrimidine derivatives, correlated with heterocyclic structures of biological importance, is also under investigation.

The Department of Research in Chemical Physics has completed a precise re-determination of the lattice constant of lead, and with the nickel fellowship has contributed a joint paper on X-ray diffraction of nickel–aluminium alloys. The quantitative analysis of crystalline mixtures by means of the Geiger-counter spectrometer, the determination of molecular structure through the analysis of infra-red and Raman vibration spectra and the design of absorption cells, instruments and techniques for Raman, infra-red and ultra-violet investigations of pure hydrocarbons in the liquid phase and under pressure are also receiving attention.

Ceramic investigations have included the utilization of bentonite in compounding plastics as an extender rather than as an inert filler, and one such type of compression-moulding plastic has reached pilot-plant production. A recent fellowship on white overcoats of high titania content has been successfully directed towards better colour values, ease of application and lighter application weights. In the metallurgical field, studies of the effect of heat treatment on the physical properties of iron powders have led to the establishment of specific processing methods, and encouraging results have been obtained in the use of specially processed silicon carbide, 'Ferrocarbo', in steel making and cast-iron founding. A multiple fellowship of the Scaife Co. has led to a better understanding of the strain patterns with variation in design of pressure vessels, especially the strain concentrations in the walls at service and testing pressure, and arc welding is being investigated as a more economical method of fabricating thin-walled pressure vessels. In a multiple fellowship on the utility of silica gel – supported catalysts for promoting hydrocarbon reactions, fairly definite conclusions have been reached for one type of catalyst on the relations between silica support and the activating materials conducive to activity. Research on gas by-products, in addition to providing the basis for the manufacture of polystyrene at Koluta, Pennsylvania, has led to methods for the removal of hydrogen sulphide in low concentrations from gas rich in carbon dioxide and for the production of ammonium sulphide from hydrogen sulphide from coal gas by the Koppers sodium carbonate hot-vacuum process. The phase relations of maleic anhydride, with particular reference to its recovery from the oxidation products of benzene, the properties of plasticized pitches, particularly rheological properties over wide extremes of temperature, the hydrogenation of anthracene cake and the oxidation of cyclohexane and ethylcyclohexane in the liquid phase and of naphthalene and benzene in the vapour phase are other subjects investigated under the fellowships of the Koppers Co., Inc.

In the petroleum field, studies of the chemical correlation of crude oils and bituminous materials have been extended, and new and more precise methods of separation and new correlations of physical properties have permitted better comparisons. The controlled polymerization of selected olefins to specific isomers has been effected, and progress made in determining the constitution of new types of sulphur compounds derived from olefins. A new class of anti-oxidants has been developed, and work with radioactive C^{14} on the mechanism of the Fischer–Tropsch synthesis has been particularly fruitful. Under the Carbide and Carbon Chemicals Corporation's multiple fellowship for organic synthesis, hydraulic brake fluids based on the 'Ucon' lubricants have been developed, and another member of the 'Ucon' family, 'Flexol Plasticizer B-400', relieved the castor oil shortage for the cloth-coating industry. An improved softener and flame-retarding composition for treating decorative paper products was also developed; and in addition to the modification of wool to increase resistance to insect attack and shrinkage, anti-static treatments for synthetic fibres are being investigated.

In the field of food products, a preliminary study has been made of the retention of folic acid in strained foods, and a new absorbent for refining sugar has been developed which can replace bone black without change in refinery practice. Work on zein has led to new dispersion systems for the preparation of coatings, inks and pigment binders; and a new technique for handling zein has yielded solutions promising for back-sizing mastic tapes and for use as undercoats to prevent absorption of nitrocellulose lacquer. Esters of inositol with drying oil fatty acids have excellent colour and cook rapidly to very clear, light, hard varnishes, while alkyds from inositol have possibilities as varnish modifiers and plasticizers for films. A suitable process has been worked out for the analysis and control of mildew-proofing agents for treating military equipment, and investigation of sizing compositions for knitting nylon hosiery yarns as well as fundamental studies of felts and felting processes are also in progress.

A wood-like product has been made from waste wood, comparable to the original wood in nailing and sawing qualities, and is now at the pilot-plant stage. Satisfactory progress has been made with a programme for controlling by instruments the continuous manufacture of *GR-S* rubber from butadiene and styrene, and a new type of chlorinated rubber, characterized by its flexibility and toughness, has been developed. An organic coating system to extend the life of steel condensers and of heat exchanger and boiler tubing has been developed and a new technique for formulating such coatings examined. Both the fundamental chemistry and the practical applications of organo-silicon compounds have continued to receive study, and the silicone fluids, through their low vapour pressure, wide range of fluidity and stability to high temperature, have solved a heating problem where pressure lines for steam or other vapours are impracticable or uneconomic. An insecticidal fellowship of the Rex Research Corporation, under which in the course of thirteen years five hundred new compounds have been prepared and tested, has now led to the use of piperonyl butoxide and piperonyl cyclohexenones on a large scale, while other compounds have shown promise. Petrolatum research has yielded a sterile petrolatum gauze burn-dressing in convenient, individual package form, and a group of hydrophile ointment bases, capable of being sterilized, with definite therapeutic properties. A method for the determination of polyethylene glycols in biological fluids has been developed, and their chronic physiological effect examined. The Industrial Hygiene Foundation has been further strengthened during the year, and a new professional committee on chemistry and toxicology appointed.

ELECTRONS AND THEIR UTILIZATION

DURING the present century, a new 'slave-trade' has arisen. Individuals are torn from their native element and are made to perform functions entirely foreign to them; immense coercion is applied to make them perform these functions; and when they have performed them they are carelessly discarded. Since the existence of these individuals—electrons—was first recognized fifty years ago, man has transformed out of all recognition his power and control over them. We are now not sure of the exact nature of the electron. Is it a particle or a wave packet? But whatever it is, wave-mechanics leads to no suggestion that the electron has a soul;

and so man can, for the present, continue his slave trade without any qualms of conscience.

The exhibition arranged by the North-West Branch of the Institution of Electronics and held at the College of Technology, Manchester, during July 22–23, might justly be described as a tour of the torture chambers of the electrons, the scale of tortures being finely graded from the mere interchange of habitat, as in accumulators, to the dragging out into free space and violent oscillation that occurs in high-frequency valves. In fact, this gradation provides a convenient basis for the classification of the various items that were shown in the exhibition.

The Chloride Electrical Storage Company exhibited many examples of accumulators and an interesting set of illustrations of rather unusual uses. These were happily chosen to cover a wide field—from the upper atmosphere (in *radio-sonde* apparatus) to below sea-level (the detection of fire-damp in mines). And to hint at more drastic electronic exercises, a portable oscilloscope was shown.

The various types of discharge lamps might well form the next subject. In these, electrons are caused to collide with the molecules of a rarified gas, which is thereby ionized; the return to the stable state is manifested by the emission of light, and, so far, this method of producing light is the most economical of power. It has, however, other advantages: it can be made almost instantaneous, by discharging a condenser through the lamp; and it can be used for stroboscopic purposes, by causing the discharge to occur periodically. Siemens showed examples of photographs taken with their 'Sieflash' argon lamp, which can produce an intensity of more than 10^8 lumens in a single flash lasting 10^{-4} sec. Ferranti's showed examples of their neon-filled 'Neostron', which is particularly designed for stroboscopic purposes.

The next stage of complication may well be taken as the radio valve; many examples were shown by Mullard's, Ferranti's, Cossor's and B.T.H. Particularly outstanding were the Mullard water-cooled 20 kW. valve and their valves made of silica, the internal construction of which was shown by sectioned models.

In addition to making electrons oscillate, we can subject them to lateral forces; this leads us to the cathode ray oscillograph—that 'maid-of-all-work' of the modern laboratory. Numerous examples of the utility of this instrument were shown, ranging from the visual observation of the electrical changes that occur in heart-beats (the Cossor electrocardiograph) to the vibration analyser of G.E.C. and Mullard. Many standard models were also shown by various firms, with suggestions for the different ways in which they can be utilized. Of particular interest were the small G.E.C. Miniscope and the Ferranti exhibit showing electron diffraction by an internally mounted specimen of zinc oxide.

Although interest was mainly centred on electrons, some space was also devoted to the means whereby electron convolutions are made possible—that is, the production of high vacua. Metropolitan-Vickers showed models of their pumps and pressure gauges, and a sectional model of a demountable X-ray tube in which these are used. Edwards also showed examples of modern pumps and the various oils used in them. People who use high-vacuum equipment are perhaps apt to take this side of their apparatus for granted, and these two stands should have helped to impress on such people that vacuum production is still a skilled art, and that improvements are continually being introduced in the process.

The range of application of all these devices was illustrated by many examples, and mention of only a few gives some idea of the uses to which electronics can be put in modern industry. There were a potentiometric titration apparatus, a layer-thickness meter for non-magnetic coatings on magnetic bases, a moisture-in-timber meter, controls to provide constant meter speed independent of load, dielectric heating for insulators or poor conductors, spot-welder control for accurate reproduction of welds, and cloth-guiding equipment for use in mills.

In short, one gained the impression that there was nothing that electrons cannot do, given the guiding hand of science behind them, and the exhibition fully served its purpose in directing attention to these powers. But largely it was preaching to the converted, and many looked with envy on the instruments that they could not purchase, or that they could only be promised months or years hence. If exhibitions such as this show us the golden age of the future, they also impress upon us the fact that it has not yet begun, and that a great deal of hard and concentrated work is necessary before we can usher it in.

NO PEARLS IN COCO-NUTS

DR. A. REYNE has recently published a detailed description of work carried out during the War "On the Structure of the Shells and Pearls of *Tridacna squamosa* Lam. and *Hippopus hippopus* (Linn.)" (*Arch. néerl. Zool.*, **8**, 206; 1947). The structures of the pearls and shells were studied by grinding surfaces in different directions, by examination of thin splinters, by slow solution in acids and by X-ray diffraction photographs. The author unfortunately lost his collection during enemy action at Wageningen in 1944 and 1945, so that a thin-section study has still to be made, and in the absence of photographs of some pearls and sections he has supplied text-figures drawn from his notebook sketches.

The structure of the *Tridacna* shell is elaborated in greater detail than in O. B. Bøggild's "The Shell Structure of the Molluscs" (1930), and the author claims to have written the first description of the *Hippopus* shell. X-ray powder photographs of the shell and the pearls of the species described show that the chief inorganic component is aragonite. The orientation of the fibrous crystallites of aragonite revealed by a photograph of a chatoyant pearl has not, however, been studied in detail.

Dr. Reyne was chief of the Cocó-nut Research Station at Menado (Celebes) 1930–33 and examined the collection of "Coco-nut pearls" of the late Dr. J. G. F. Riedel, who claimed to have found one in a coco-nut which he opened himself (*Nature*, **115**, 138; 1925). Dr. Reyne concludes that these are all true *Tridacna* pearls and that Riedel had been deceived by some trick of the natives. Even in 1835 Quoy and Gaimard were already of the same opinion, who writing of *Tridacna* said "c'est aussi le lieu de parler de ces perles assez grosses, mais peu régulières, que secrète le manteau, et qui, dans plusiers endroits de l'Inde, aux Moluques et aux Mariannes, passent pour être un produit de la végétation, et se trouver dans l'intérieur de la noix de coco".

FORTHCOMING EVENTS

Monday, November 10

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Mr. S. S. Carlisle: "An Experimental Electrical Pressure Meter for Measurement of Furnace Roof Differential Pressures".

Tuesday, November 11

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "The Vegetation of the Chalk". 3. "Colonisation and Succession; The Flora of Arable Chalk Soils; Chalk Scrub Vegetation".

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. T. A. Hall and Dr. G. G. Haseldon: "The Purification of Gases in Low Temperature Processes"; Dr. M. Ruhemann: "The Ammonia Absorption Machine".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "What Equipment is Necessary for the Servicing and Testing of Electronic Devices?" (to be opened by Wing Commander P. Allerston).

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Mr. J. C. Williamson: "The Metallurgy of Musical Instruments".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the GRAVESEND ENGINEERING SOCIETY, at the Royal Clarendon Hotel, Gravesend), at 7.30 p.m.—Films and Discussion on "Water Treatment" (organised by Mr. S. Stevens).

Wednesday, November 12

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. R. N. J. Saal: "Rheological Investigation of Asphaltic Bitumen in connexion with its Technical Applications".

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Mr. E. Devons: "Economic Planning".

Thursday, November 13

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 4 p.m.—Discussion on "Supersonic Absorption in Liquids" (to be opened by Mr. J. M. M. Pinkerton).

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. A. V. Hill, C.H., F.R.S.: "The Resolution of Physical and Chemical Events in Muscular Contraction"; Mr. R. M. Davies: "A Critical Study of the Hopkinson Pressure Bar".

BRITISH GLACIOLOGICAL SOCIETY (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5 p.m.—Mr. H. F. P. Herdman: "The Southern Pack Ice".

CHEMICAL SOCIETY (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. L. Hunter: "The Hydrogen Bond in Organic Chemistry".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Mr. E. W. H. Selwyn: "Photographic Resolving Power of Lenses".

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. A. Landolt: "Hydrophobic Melamine Compounds in Textile Processing".

CHEMICAL SOCIETY (joint meeting with the LOCAL SECTIONS of the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. Philip Eggleton: "Diffusion in Biological Processes".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. Hans Flück: "Chemical and Biological Aspects of the Conservation of Vegetable Drugs".

TEXTILE INSTITUTE, MACCLESFIELD, LEEK AND DISTRICT SECTION (joint meeting with the LEEK TEXTILE SOCIETY, at Nicholson Institute, Leek), at 8 p.m.—Dr. V. G. Jolly: "Abnormal Colour Vision".

Wednesday, November 12—Thursday, November 13

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1).—Autumn Meeting.

Friday, November 14

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. S. A. Woods: "Colour in Industry with particular reference to Painting Machinery".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

CHEMICAL SOCIETY (joint meeting with the SOUTHAMPTON UNIVERSITY COLLEGE CHEMICAL SOCIETY, in the Physics Department, University College, Southampton), at 5 p.m.—Dr. U. R. Evans: "The Corrosion of Metals".

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS GROUP (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. H. E. Rose: "The Mechanical Differential Analyser, its Principles, Development and Applications"; Dr. S. C. Redshaw: "An Electrical Potential Analyser".

PLASTICS INSTITUTE (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—"Injection Moulding of New Thermoplastics".

INSTITUTE OF ECONOMIC ENGINEERING (at the Waldorf Hotel, Aldwych, London, W.C.2), at 7 p.m.—Mr. Wilfred B. D. Brown: "A Proposed Code of Human Management".

INSTITUTE OF WELDING, NORTH LONDON BRANCH (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. D. Hanson: "Training for Industry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

STATES AGRICULTURAL ADVISORY OFFICER—The States Supervisor, States Office, Guernsey (November 15).

LECTURER IN MATHEMATICS—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (November 15).

RESEARCH PHYSICIST—The Director, Institute for Industrial Research and Standards, 45 St. Stephen's Green, Dublin (November 15).

LECTURER IN CHEMISTRY up to B.Sc. standard—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (November 15).

RESEARCH FELLOWSHIP IN RHEUMATISM—The Registrar, The University, Leeds 2 (November 15).

SENIOR ASSISTANTS (2) IN THE DEPARTMENT OF MECHANICAL ENGINEERING, LECTURERS (3) IN MECHANICAL ENGINEERING (Design), and a LECTURER IN MATHEMATICS—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (November 15).

GRADUATE LECTURER IN CHEMISTRY and related subjects at the Blackpool Technical College and School of Art—The Chief Education Officer, 3 Caunce Street, Blackpool (November 15).

TEACHER OF MINING SUBJECTS at the Openshaw Technical School—The Chief Education Officer, Education Offices, Deansgate, Manchester 3 (November 15).

INSTRUCTOR IN HORTICULTURE at the Farm Institute, Merrist Wood, Worplesdon—The Chief Education Officer, County Hall, Kingston, Surrey (November 15).

ASSISTANT LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, University College, Hull (November 17).

LECTURER or ASSISTANT LECTURER IN ZOOLOGY—The Registrar, King's College, Strand, London, W.C.2 (November 22).

ASSISTANT LECTURER (temporary) IN BOTANY—The Principal, Royal Holloway College, Englefield Green, Surrey (November 23).

ASSISTANT EXPERIMENTAL OFFICERS (temporary, Ref. G.460/47A), and EXPERIMENTAL OFFICERS (temporary, Ref. G.461/47A), IN THE DEPARTMENT OF AGRICULTURE FOR SCOTLAND, for Inspection, for Insect Infestation, of foodstuffs, warehouses, shops and various storage and food manufacturing premises and associated laboratory work—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (November 24).

LECTURER IN GEOGRAPHY—The Registrar, The University, Manchester 13 (November 28).

LECTURER or ASSISTANT LECTURER with special qualifications either in ECONOMIC HISTORY or in APPLIED ECONOMICS—The Registrar, University College, Hull (November 29).

PHYSICIST to carry out investigations into the structure and physical properties of cellulosic fibres, and a LABORATORY ASSISTANT to the Senior Physicist—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey (November 30).

EXPERIMENTAL OFFICER, and an ASSISTANT EXPERIMENTAL OFFICER, for work in London on insecticides—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (November 30).

SENIOR LECTURER IN BIOCHEMISTRY—The Secretary of University Court, The University, Glasgow (November 30).

LECTURER IN ENGINEERING at Peterborough Technical College—The Chief Education Officer, Education Offices, Town Hall, Peterborough (November 30).

METEOROLOGICAL OFFICER CADETS (10) in the Department of Industry and Commerce—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 3).

LECTURER IN PHYSICS—The Principal, Royal Technical College, Peel Park, Salford 5.

LABORATORY SUPERINTENDENT by the Government of Nigeria for Medical Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18391.

HEAD OF THE ENGINEERING DEPARTMENT of the County Technical College, Wednesbury—The Director of Education, Dept. F.E., County Education Offices, Stafford.

BIOMETRICIAN (Ref. M.N.18186), an AGRONOMIST (Ref. M.N.18175), and a TOBACCO BREEDING SPECIALIST (Ref. M.N.18181), for the Directorate-General of Agriculture, Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting the appropriate Ref. No.

LABORATORY STEWARD (temporary, man or woman)—The Principal, Brixton School of Building, Ferndale Road, London, S.W.4.

LABORATORY STEWARD IN THE DEPARTMENT OF BOTANY, and a LABORATORY STEWARD IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

ASSISTANT TECHNICAL SECRETARY (male) by the Ironmaking Division—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

RESEARCH ASSISTANT IN THE POMOLOGY DEPARTMENT—The Director, John Innes Horticultural Institution, Merton, London, S.W.19.

ASSISTANT TECHNICIAN IN CHEMISTRY DEPARTMENT—The Secretary, College of the Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1.

SCIENTIFIC ASSISTANT for bureau literary work—The Director, Imperial Bureau of Animal Health, New Haw, Weybridge, Surrey.

LECTURER IN MECHANICAL ENGINEERING—The Principal, Erith Technical College, Erith Road, Belvedere, Kent.